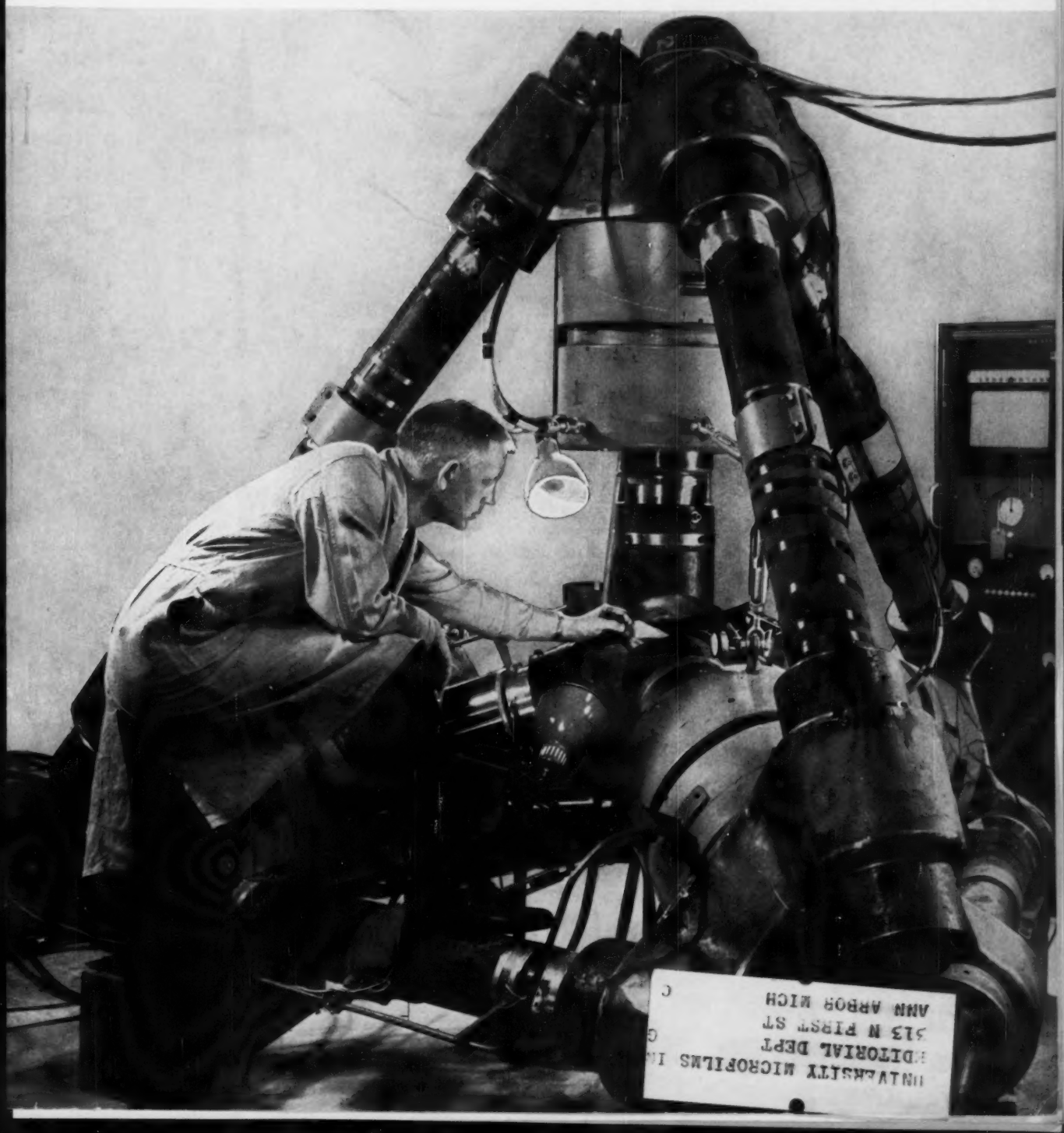
November 18, 1960

electronics

Four rams, below, push pistons against tetrahedron holding semiconductor sample being tested at high pressure. *See p 90*

First engineering facts on f-m stereophonic radio tests, *p 85*

A McGraw-Hill Publication 75 Cents



UNIVERSITY MICROFILMS INC
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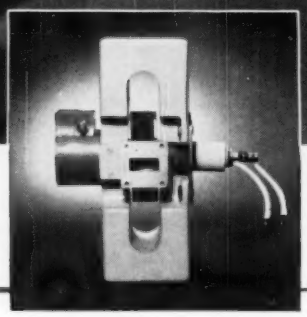
New Raytheon tunable magnetron improves airborne radar performance



250 kW QKH-1000—all ceramic and metal tube—improves performance of existing systems, provides increased capability for new systems.

This new X-band pulsed magnetron—specially designed for airborne applications—results from Raytheon's long experience in quantity production of magnetrons for use under severe environmental conditions.

The tube is rapidly tunable from 8,500 to 9,600 Mc, with a typical tuning rate of 100,000 Mc/sec in the hydraulically tuned version. Ceramic construction and newly-designed cooling fins provide high ambient temperature tolerance. Study programs are underway to permit operation to 350°C.

The tube's heliarc welded output assembly and magnet shape enhance its physical rigidity. Unique anode construction achieves better voltage and frequency stability. Designed for economical volume production, the QKH-1000 directly replaces the RK-6249 magnetron in existing systems.

QKH-1000—GENERAL CHARACTERISTICS	
Power Output	250 kW (nominal)
Frequency Range	8500-9600 Mc
Anode Voltage	27.5 kV
Anode Current	25 amps (peak)
Stability	0.2% missing pulses
Bandwidth $\frac{1.65}{t_p}$ Mc; i_b	$= 25 \pm 15\%$ amps (peak)
Pulse Widths	Up to 3.3 μsec

Write for detailed application information to Raytheon Company, Microwave and Power Tube Division, Waltham 54, Massachusetts. In Canada: Waterloo, Ontario. In Europe: Zurich, Switzerland.

RAYTHEON COMPANY

MICROWAVE AND POWER TUBE DIVISION

RAYTHEON

November 18, 1960

electronics

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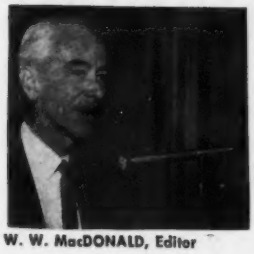

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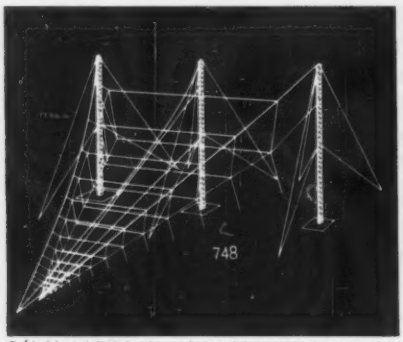
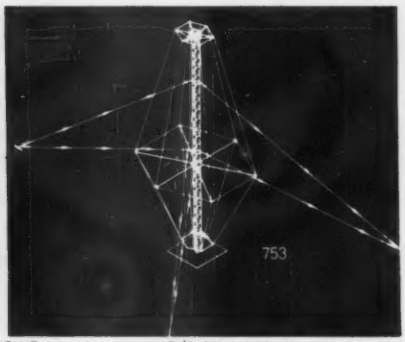
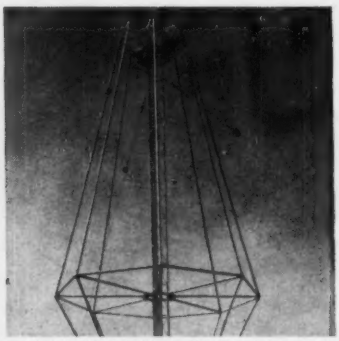
GRANGER ASSOCIATES' broadband **log-periodic** and conical monopole **antennas** are making an important contribution to more **flexible,** more **reliable** and more **economical hf radio communications.** They offer direct **savings** in **land,** in **power** and in **circuit down time.** Each design provides a **low and constant input VSWR** over its entire operating frequency range—to minimize transmission line losses and equipment tune-up time. These antennas offer **radiation patterns** with **excellent broadband properties.** Take-off angle can be controlled for each application. Since both radiation pattern and input impedance are essentially **constant vs. frequency,** and efficiencies are high, it is possible to radiate a maximum of **power** in an optimum **direction.** G/A also offers broadband **balun transformers** and **receiving and transmitting multicouplers** which permit use of multiple equipments on a single antenna A staff study that explains **GRANGER ASSOCIATES'** hf communications accessories and their applications is **available now.**

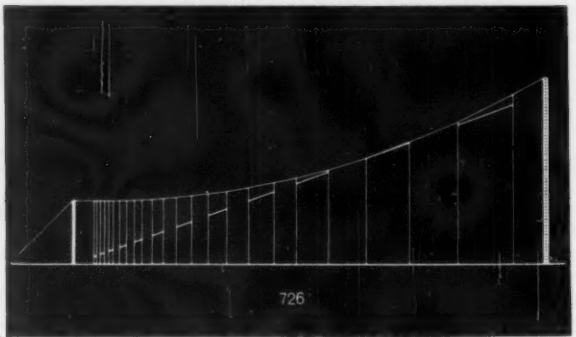


G/A Model 748 horiz. polarized log periodic antenna. VSWR less than 2:1. Gain 13 db (nom.). Take-off angle as low as 23° with 200' tower.





G/A Model 753 conical monopole omni-azimuthal antenna. For broadcast applications; easily stowed and erected. 6-24 megacycle version has VSWR of 2.1:1.



G/A Model 726 vertically polarized monopole log periodic antenna. VSWR of 2.1:1 (nominal). 10 db gain. Extremely low take-off angle. Several antennas can be arrayed to compress azimuth beamwidth.

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CONDENSED DATA

Regulation: *Line* Better than 0.15% or 0.3 Volt (whichever is greater). For input variations from 105-125 VAC.

Load Better than 0.25% or 0.5 Volt (whichever is greater). For load variations from 0 to full load.

Transient Response: *Line* Output voltage is constant within regulation specifications for step-function line voltage change of plus (+) 10 volts or minus (−) 10 volts rms within the limits of 105-125 VAC.

Load Output voltage is constant within regulation specifications for step-function load change from 0 to full load or full load to 0.

Ripple and Noise: Less than 3 millivolts rms.

AC Output: (unregulated) . . . 6.5 VAC (at 115 VAC Input). C-200 Series . . . 10 AMP; C-400 Series . . . 15 AMP; C-800 Series . . . 20 AMP; C-1500 Series . . . 30 AMP.

AC Input: 105-125 VAC, 50-400 CPS

Controls: DC Output Controls: Band-switches and screw-driver adjusting vernier-control, rear of chassis.

LA 111

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CROSSTALK

electronics

Nov. 18, 1960 Volume 33 Number 47

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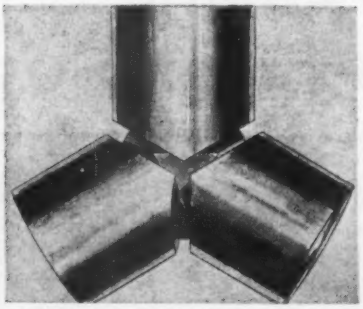

HIGH-PRESSURE RESEARCH. Accompanying photograph is a close-up of the tetrahedron and pistons of the high-pressure apparatus appearing on this issue's front cover. High pressure is playing an important role in semiconductor research. For an insight into this fascinating work, turn to p 90 and read the article by D. Warschauer of Raytheon.

MEDICAL ELECTRONICS is getting new help from our industry through use of computers, nuclear magnetic resonance and electron precision resonance spectrometers and electronic biomechanical measuring techniques. This week (see p 46) Associate Editor Bushor interprets latest trends in these new areas and the continuing investigations of established applications. He is just back from on-the-spot coverage of technical sessions and symposia at the 13th Annual Conference on Electrical Techniques in Medicine and Biology, which was held in Washington, D. C.

TWO-COLOR TV. Engineers who are primarily in entertainment electronics have their annual get-together at the EIA's Radio Fall Meeting, which was held a few days ago in Syracuse, N. Y. Many persons came to the meeting wondering about two-color tv. Where does it stand? This week, Associate Editor Flynn provides some information. Engineers he interviewed at the meeting say the difference in color isn't that striking. And savings in production costs, so far, aren't significant.

For more details on two-color television—and a summary of interesting technical highlights of the three-day Radio Fall Meeting—turn to p 49.

Coming In Our November 25 Issue

SPECIAL REPORT. Widespread research marks our industry's present program for realizing the promise of microminiaturization.

This promise—high reliability, low cost and small size—may be the answer to the next generation of developmental problems facing electronics engineers.

As readers of ELECTRONICS well know, microminiaturization is taking many forms (p 51, May 22, 1959; p 35, June 26, 1959; p 49 Dec. 11, 1959; p 69, May 13, 1960). Next week's Special Report on microminiaturization by Associate Editor Perugini and Assistant Editor Lindgren will bring you up to date on the different programs, approaches and techniques. You'll learn where we stand on component, circuit and function oriented approaches, and how microminiaturization techniques are being applied to equipment and systems.

You won't want to miss this comprehensive survey which was almost a year in preparation.

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FXR's Broadband Fixed Coaxial Attenuators are extremely useful and completely dependable in applications requiring isolation between RF components and extending power meter ranges. They may also be used for the calibration of directional couplers, in obtaining antenna characteristics and for similar applications. These attenuators have exceptional stability and are capable of withstanding appreciable overloads and peak power with no change in characteristics. They have high shock and vibration resistance and exhibit a negligible change of attenuation under humidity and temperature cycling.

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N180B	1.0-11.0	1.3	(− .6) (+ .7)	42.00
N180C	1.0- 2.0 2.0-11.0	1.35 1.30	(−1.2) (+1.3)	42.00
N180D	2.0- 3.0 3.0-11.0 11.0-12.4	1.35 1.30 1.40	(−1.3) (+1.9)	42.00

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COMMENT

Ophthalmic Electronics

ELECTRONICS in the recent past has published many fine articles in the field of medical electronics. These started me to thinking about a medical area in which very little has been done in the past several hundred years.

Countless millions of Americans have defective vision. A large percentage of these need only a single, simple lens to alter the light paths sufficiently to accommodate their focusing range. In other words, their muscles are fine; their eyeballs are either too large or too small for the existing lens.

Glasses are an unsightly, inconvenient, expensive and cumbersome method of circumventing this defect. Up until now, at least, they were the only way; but why has no one considered altering the refractive index of the eye fluid?

The brute force method of doing this might be by an operation to remove part of the eye fluid and replace it with a tolerable compound which would raise or lower the refractive index the desired amount. The success of this method would depend on finding suitable fluids; it would also depend on the rate at which the eye fluid is replaced by normal body processes.

A more sophisticated solution, though, and one which might more reasonably call on electronics for assistance, would require locating the glands, nerves, and so forth, which control the refractive index of the existing fluid, and then making suitable changes in order to shift the index. This type of solution would be better, and probably would be permanent.

RICHARD G. DEVANEY
KINGSPORT, TENN.

Reader Devaney is suggesting a type of microsurgery that exceeds even the present concepts of microsurgery. It certainly will take a great deal of research and investigation before such an idea can be considered even experimental.

Transistorization

Don't you think the time is long overdue when use of the term *transistorized* passed into oblivion? If a piece of equipment is designed for transistors, it is a *transistor* receiver, not a *transistorized* receiver, for instance.

If originally tube designed and subsequently converted to transistors, of course, *transistorized* makes sense.

Otherwise, your book is pretty darn good. . .

WALT BOYD
SACRAMENTO, CALIF.

Soviet Technology

I quote the following from a report on Soviet technology ("Soviets Are Pushing All Technologies"), which appeared on p 40 of your Oct. 21 issue:

"In the Azerbaijan SSR, a young researcher has used high-voltage pulses to alter the internal structure of cottonseed, causing an increase in germination speed and higher cotton yield. Seeds were soaked in water, dried, and subjected to 2,500-v fields. Plants sprouted two or three days sooner than usual, had more buds, ovaries and bolls."

We are very much interested in further information on this report. . .

S. O. NELSON
U. S. DEPARTMENT OF AGRICULTURE
LINCOLN, NEBR.

The information came to us from a Tass article summarizing a report by Manf Kalantarev of the Azerbaijan Power Institute Laboratory. As far as we can determine, the work reinforces conclusions drawn from earlier research done here and abroad.

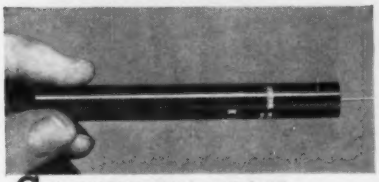
Financial Typo

On p 20 (Financial Roundup) of your issue of Oct. 28, you indicated our earnings as "27 cents per common share." We believe this is a misprint since the published earnings for our company are 57 cents per common share. . .

CHARLES J. EISEN
POLARAD ELECTRONICS
LONG ISLAND CITY, N. Y.

GENERAL INSTRUMENT SEMICONDUCTOR REPORT

Design Notes...



G ENCAPSULATES UNIQUE HOLD-OFF DIODE

Problem: A well-known systems manufacturer needed a series hold-off diode for use in a dc resonant charge radar modulator. Conditions: PIV of 12KV; Operating temperature, 100° C; Inverse current at PIV, 150 μa; Average current, 120 ma; Peak charge current, 260 ma. *In addition,* specifications called for a transient capability of 21 KV dc for .07 second.

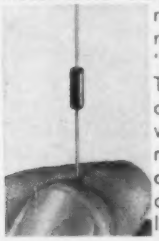
Solution: G produced a unit which far exceeded these requirements. The G CIRCUIT CAP (pictured above) is only ½" in diameter and 4¼" long. It is capable of continuous operation beyond maximum required parameters.

ENCAPSULATED ASSEMBLIES BUILT TO SPEC MEASURES 1 CUBIC INCH

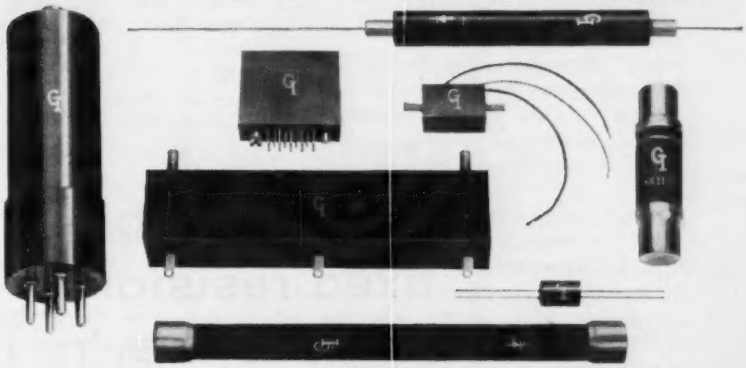
G recently designed a comparator bridge for missile use, which contains 4 resistors and 16 diodes (print at right). The entire bridge is encapsulated within a 1 cubic inch module, has 8 studs for plug-in mounting. The unit meets customer requirements, and is capable of continuous operation in ambients up to 150° C.

MICROMINIATURE DIODE DESIGNED FOR 1,500 PIV SERIES OPERATION

General Instrument Engineers solved another customer problem in a diode that measures .08" diameter by ¼" long. Space requirements made it necessary to assemble an "electrically cold" unit. This specially designed diode was produced with the rigid requirements of 1,500 PIV, leakage of less than .02 μa, and a forward drop of less than 2V @ 100 ma.



G Offers Reliability on the Circuit Level



GENERAL INSTRUMENT CIRCUIT CAPS DESIGNED TO YOUR SPECIFICATIONS . . . SAVE COST OF

• Engineering • Production • Quality Control

General Instrument offers circuit modules with the exact parameters needed for your specialized applications . . . regardless of configuration, electrical or environmental requirements. Typical applications include: rectifiers, amplifiers, comparators, bridges, limiters, blocking and flip-flops.

These packaged assemblies provide proved reliability for the entire circuit . . . feature high resistance to vibration, shock, moisture and humidity, combined with high heat dissipation. These assemblies range from printed circuit boards, ultra-high PIV microminiature diodes, minimal size encapsulations, as well as packages weighing hundreds of pounds.

• **ENGINEERING:** Experienced General Instrument Engineers study your specifications, draw on G research, development and production facilities in making an assembly to exceed your most stringent requirements.

• **PRODUCTION:** Years of General Instrument experience in volume semiconductor manufacture is applied to the production of "CIRCUIT CAPS". G saves you the expense of stocking, testing, selection and encapsulation. Maximum use of welded connections assures excellent resistance to vibration and shock.

• **QUALITY CONTROL:** Components, as well as completed "CIRCUIT CAPS" are subjected to 100% electrical and environmental testing . . . exceeding the most stringent industrial and military specifications. Finished units are *guaranteed* to surpass your most rigid requirements.

CONTACT GENERAL INSTRUMENT for full information on the services offered by the Special Products Division. Our engineers will work closely with you—in your own plant, if necessary—to produce a "CIRCUIT CAP" designed for your modular applications or complete circuit needs.

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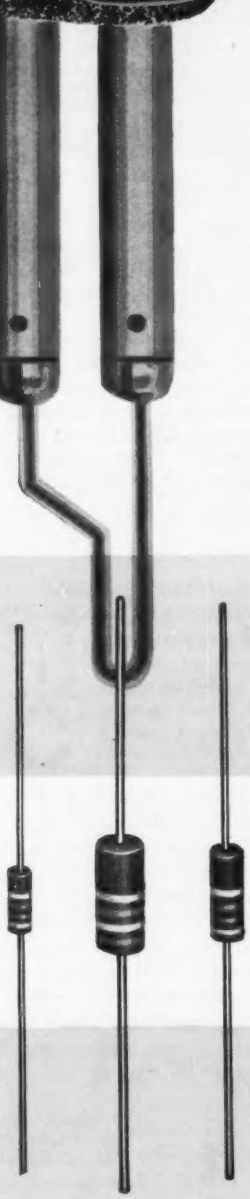
Immediate Local Deliveries for small runs, production emergencies or design needs . . . from over 30 strategically located parts distributors . . . At factory prices in lots up to 1000 of a value.

Would you buy fixed resistors just because they're the **easiest to solder?**



Of course you wouldn't!

But when you add the highest degree of "solderability" of any resistors on the market to top-notch reliability in other physical and electrical characteristics — well, that's something else. Like a lot of other cost-conscious producers, you'll then be using Stackpole Coldite 70+ Resistors!

Stackpole Coldite 70+ "solderability" saves time and money in your production. It assures perfect connections that eliminate a lot of possibilities for costly field service later on.

Coldite 70+ performance fully matches the "solderability" of the leads. They're designed to meet or excel MIL-R-11 in every respect. And they're tops in load life, humidity and moisture tests!

Electronic Components Div.—**STACKPOLE CARBON CO.**, St. Marys, Pa.

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ELECTRONICS NEWSLETTER

After the Election Optimism . . . & Caution

THE LAST HURRAH is in, now what?

That's the big question as a Kennedy Administration comes into view this week. And this is the outlook: Our industry will continue to do well—but watch a couple of potential trouble spots.

One midwest executive sees a 10-percent rise in business. On the other hand, west coast official is worried about Kennedy's ties with labor and unions. (Question: Will automation be retarded?)

A New England executive sees a lot of name-dropping . . . and finding . . . in Washington. Nothing social; strictly business as longtime government contacts leave office and new faces move in.

As soon as last week's election was settled, ELECTRONICS editors began asking executives and engineers in our business: What affect will the new Administration have—and why? Answers follow.

Pacific Coast Sees 'Speedier Funding'

ON THE WEST COAST, post-election comments are running like this:

An executive doing business with the military says: "We expect a speedier relief of funding in R&D space programs. Kennedy has been harping on the declining prestige theme and is obligated to take some definite action to show he's going to get the nation moving again."

From a spokesman for an industrial equipment firm: "I doubt that Kennedy's being elected will have much effect on our sector of electronics, which is industrial automation and process control. The trend toward more automation is already definitely established. One thing we are somewhat apprehensive about is Kennedy's ties with labor and unions, and whether he might side with them in attempting to retard automation of industry.

"I think we may get a small boost in sales to firms which are engaged in military electronics and get stepped-up contracts if Kennedy keeps his promises. Another thought: Some of our business is with the oil industry, and if Kennedy goes to work on depletion allowances, oil companies will not be anxious to initiate further cash outlay."

A consumer equipment manufacturer thinks: "Prior to election there was an environment of uncertainty, and few people were buying things they didn't absolutely need. Now that there's no more uncertainty about the outcome, we feel people will start buying radios and tv."

Midwest Forecasts 'Pickup in Tv Sales'

THIS IS WHAT some electronics executives in the midwest are saying:

Donald C. Potter, vice president and general manager, Stewart-Warner: "With Kennedy in, we expect defense expenditures to be somewhat greater. Since defense represents 80 percent of the work of our industry, we may expect a general increase in electronic business of about 10 percent over the next few years."

Edward R. Taylor, executive vice president, Motorola: "We haven't found much disparity between the candidates in matters affecting our business, so we don't expect the election will make much difference.

"To the extent that the public is relieved that the campaigning is over, we may expect some lift in buying psychology. Other than that, we'll be waiting, like almost everyone else, to see just what types of policies will be adopted by the new administration."

Ross Siragusa, Jr., vice president, Admiral: "We do believe that tv sales are probably close to bottoming out now—after their slump of the past few months—with the pick-up coming in the first or second quarter of next year. I expect these results would have been pretty much the same no matter which way the election turned out."

Robert F. Halligan, executive vice president, Hallicrafters: "The Democratic victory will have little effect on continuing growth of the electronics industry, particularly for companies like ours, in the front lines of our worldwide offense and defense systems through government contracts.

"Both political parties have realized that as long as any one nation or group of nations comprises a threat to world peace, the U. S. has no choice but to stay ahead of its potential enemies in all phases of technology, and nowhere is this more relevant than in electronics."

"The nation's economic growth, its mounting population and the increasing impact of automation will have far greater influence on consumer and industrial aspects of our industry than any change in political administration."

Richard A. O'Connor, chairman of the board, Magnavox: "Both candidates have indicated need of additional emphasis in the area of national defense, and, should the new congress agree, there may be some upsweep in military electronics. Electronic products in the consumer market, like all consumer goods, are directly related to the climate of the national economy."

New England Expects 'Scurrying for Contacts'

"ONE IMMEDIATE PROBLEM will be in the number of new faces in Washington."

Speaking was the president of a military electronics company in the east. Counting of presidential votes was over. He was weighing the pros and cons of a Kennedy administration.

"Well-established sources of information on contracts, etc., will presumably be out," he continued. "This may be true also in the scientific field, in top levels of ARPA and NASA, for example.

"There will be a lot of scurrying around in Washington to set up new contacts."

The executive says he sees little change in the level of defense contracts. "Both parties," he says, "are strong on the need for defense spending."

Another executive of an east coast industrial electronics firm feels this way:

"I see more business, but counter-balanced by heavier corporate taxes. I expect long-term socialogi-

cal changes including emphasis on social welfare legislation, decreased productivity of labor via contract concessions from management. I fear this will ultimately lower general standard of living."

Navy Now Testing Advanced Sonar Systems

SONAR SYSTEMS capable of reaching 30, 70 and 100 miles are now being tested by the Navy for general deployment in the antisubmarine fleet. One system reportedly "just going into saltwater" uses a transducer weighing 30 tons, is built to operate both actively and passively, can reach out ten times the distance of conventional sonars under worst ambient conditions.

System now under test was built for submarine use by Raytheon; other models for destroyer installation are being built by Edo and GE.

Army Awards Advent Contract

MICROWAVE COMMUNICATIONS system for Project Advent will be developed by Bendix under a Signal Corps contract. The half-ton Advent satellite will be placed in a 22,300-mile-high orbit some time in 1962.

The company's systems division will design the satellite repeater, special-purpose ground equipment and checkout gear, and will provide the communications systems engineering. Radio division will design and construct ground terminal equipment (to be located near Vandenberg AFB in California and Fort Dix, N. J.) and will produce the airborne microwave repeater equipment. Development and preliminary design of shipboard terminals for Navy use will also be done by Bendix. Overall cost of Advent, including launching vehicles, will be $174 million.

Air Force Pushes Pneumatic Computer

PNEUMATIC COMPUTER developments will eliminate electronic devices from some signal and power applications in hot-gas environments, particularly airborne and spaceborne, researchers were predicting this week. Under Air Force sponsorship, a mechanical engineering group at MIT is intensifying development of pneumatic computational components, mostly high-gain relay devices, and hot-gas servos and valves. Interest centers on all-mechanical or all-pneumatic systems where conversion to electronic signals is not desirable, and on performance in extremely high ambient temperatures where even the most advanced electronic devices may not be satisfactorily operable.

Boost Orthicon Speed To 125,000 ASA

ELECTRONIC PULSING of conventional image orthicon steps up its effective speed to 125,000 ASA, opens the way for its use in optical tracking of space probes to the moon—or to Mars and Venus.

Experiments by Northwestern University researchers increased sensitivity by placing short positive charges on both target and grid of the tube just before and during readout. Researchers R. Aikens and G. Barton tested the souped-up orthicon in recent investigations at the Organ Pass, N. M., satellite tracking station.

University's newly announced Project Cat-Eye will couple the new pulsing system to a 36-inch telescope, will gain the effect of a 360-inch telescope for balloon-borne sightings from the near edge of space (ELECTRONICS Newsletter, p 11, Nov. 11).

Moth Countermeasures Fight Bat's Sonar

COUNTERMEASURES TECHNIQUES are used by moths against the ultrasonic radar of bats, according to Kenneth Roeder, professor of physiology at Tufts University. Roeder's studies show the moth's receiver has a frequency response of 10 to 100 Kc and a range of 100 feet. He has recorded on tape the output of the receiver—millivolt pulses with milliseconds duration. The physiologist is trying to determine how much information the moth can get on the bat's maneuvers and how effectively the moth uses this information to evade the bat.

Sift Maintenance Plans For New Weapons Systems

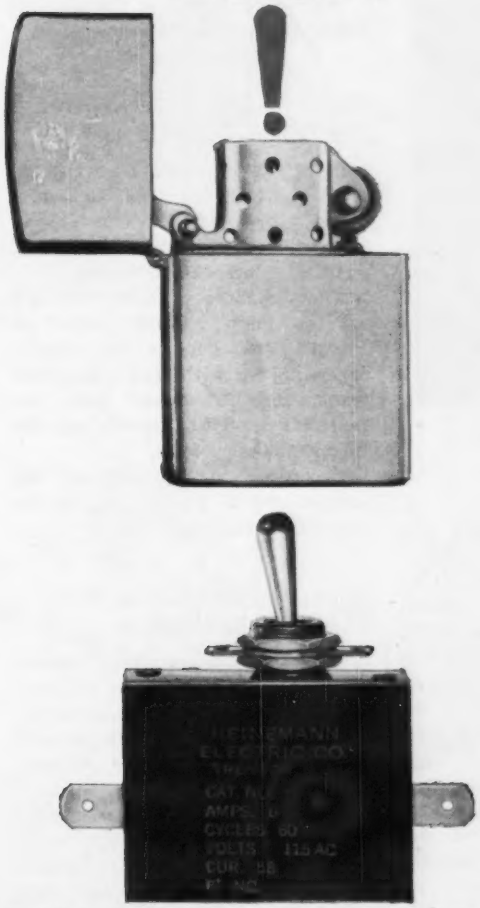
STUDY TO ESTABLISH next-generation design criteria and maintenance philosophy for Air Force weapon systems, test and checkout equipment now being made by the Motorola military electronics division and the Douglas missiles and space systems engineering department may influence total Air Force planning for future weapon support gear.

Principle objectives of study requirement SR-17530, titled "Design Criteria for Automatic Test and Checkout Systems," are to: validate operational and maintenance requirements for test and checkout of Air Force weapon systems through 1975; corroborate design criteria to ensure compatibility of future weapons and associated gear; determine the feasibility of standardizing test and checkout equipment and procedures; and of designing an integrated multipurpose automatic test and check-out system for future weapons systems.

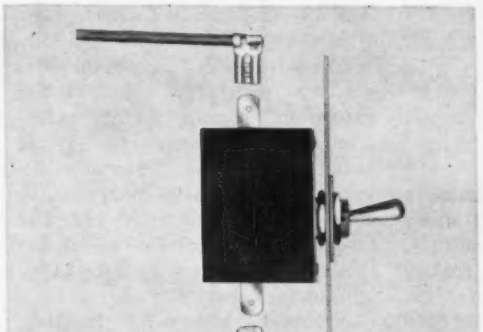
Conventions Valuable, Survey Suggests

EFFECTIVENESS of electronics conventions was recently surveyed by Facts Consolidated, research and market analysis firm. Survey of reactions to 1960 Wescon showed that 93.5 percent of people interviewed think the convention advanced their knowledge of the industry. Of 730 personal interviews from professional and management men, 89.6 percent said lectures and technical discussions advance the electronics art, 2.9 percent thought not. Over half indicated they attended or planned to attend technical discussions, 36 percent didn't expect to participate. Total of 86.3 percent rated lectures and technical discussions important. Majority of 89.6 percent indicated the exhibits advanced the electronics art, and over 88 percent thought exhibits would help them in their jobs.

LOOK !



A NEW HYDRAULIC-MAGNETIC BREAKER NO BIGGER THAN A POCKET LIGHTER



Light . . . small . . . a snap to install! This 1½-ounce circuit breaker can help you out of a tight spot, if you're cramped for component space. Only 2½" x ⅝" x 2¼" overall, it can take the place of both a fuse and a switch—and save you installation time and trouble, in the bargain. A single half-inch hole is all you need for mounting, and there are only two connections to make, instead of four or more. (The breaker's "universal" terminals let you use the kind of connection best suited to the job, too—soldered, solderless, or screwed.) You can have this breaker in any integral or fractional current rating from 0.050 to 15 amps, at 110V, 60 or 400 cycles AC, or 50V DC. Whatever rating you spec will be decimal-point precise—and permanent (you don't have to de-rate the hydraulic-magnetic breaker for high ambient temperatures). Bulletin VP will give you more information. A word from you will put a copy in the mail.

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SA 2328

ELECTRONICS ABROAD

New Landing System For British Airports

PRESTWICK, SCOTLAND—Following shakedown tests for a new instrument landing system made by ITT's British associate company, Standard Telephones & Cables, Ltd., the equipment was installed at this airport and at Gatwick, Ringway and Renfrew. The gear was put through its paces at Hurn airport late this summer by Ministry of Aviation officials.

The new system operates on any one of 39 channels between 108.1 and 111.9 Mc., operates through two identical r-f and modulator sections which feed two antenna arrays. Each array feeds a separate signal zone.

Nigeria Planning to Use Electronic Time Standard

LAGOS—New national radio station slated to go in operation in the near future will take its time from an electronic crystal-controlled chronometer system made by Sperry Gyroscope Co., Ltd., of England. System designers say the standard is accurate to better than 15 seconds a year. The system will contain a master transmitter providing both one-second pulses and half-minute pulses for up to a score of slave clocks.

Provisions will be made on the station control console to synchronize the master and slave clocks with Greenwich Meridian Time, for example, by the BBC time signal.

Tone signals will be transmitted every 15 minutes at 800 cps.

New Tv Network Slated For Cambodian Viewers

PHNOM PENH—Cambodia's government has awarded a $390,000 contract to Nippon Electric Co. of Japan for complete installation of a 100-kw television network.

The Japanese company will set up the main antenna tower in Phnom Penh, here in the nation's capitol, along with studio gear and transmitters. A 100-kw relay station will also be set up on the Bokor plateau.

According to the contract, the station should go on the air by August of next year.

International Television Net Formed in East Europe

ZURICH—Major countries of eastern Europe have formed an international tv network called Intervision. (Western Europe's international net is called Eurovision.) Already in operation are links between Berlin, Warsaw, Prague and Budapest. Planned for 1961 are connections with Leningrad, Moscow and Kiev, with expectations that 1962 will see Bucharest, Sofia and Tiran in the hookup. Future links may reach Vladivostock and Peking.

Germany, Czechoslovakia, Poland and Hungary now have tv relay links extending roughly 2,000 miles. They comprise 30 transmitters and reach about 10 million viewers, not including USSR.

Computer to Control Uranium Reactor

PARIS—Digital computers built in the U. S. will be used by France's state-owned electric power utility, Electricite de France, to control two of the three natural uranium gas-cooled reactors the utility is now planning.

Compagnie Europeene d'Automatisme Electronique (CAE), has already delivered the first unit, an RW-300, to EDF, with two more slated for early delivery: one for a second EDF reactor, the third to control a 250-Mw thermal power station to be built near Paris.

The two-computer system will provide automatic detection of fuel cladding ruptures for the reactors, the first of which—at Chinon in the Loire valley—is scheduled to go critical in 1961.

CAE was formed last July by Thompson Ramo Wooldridge, Compagnie Generale de Telegraphie Sans Fil, Societe Intertechnique.

Australians Develop Tiny Phase Sequence Detector

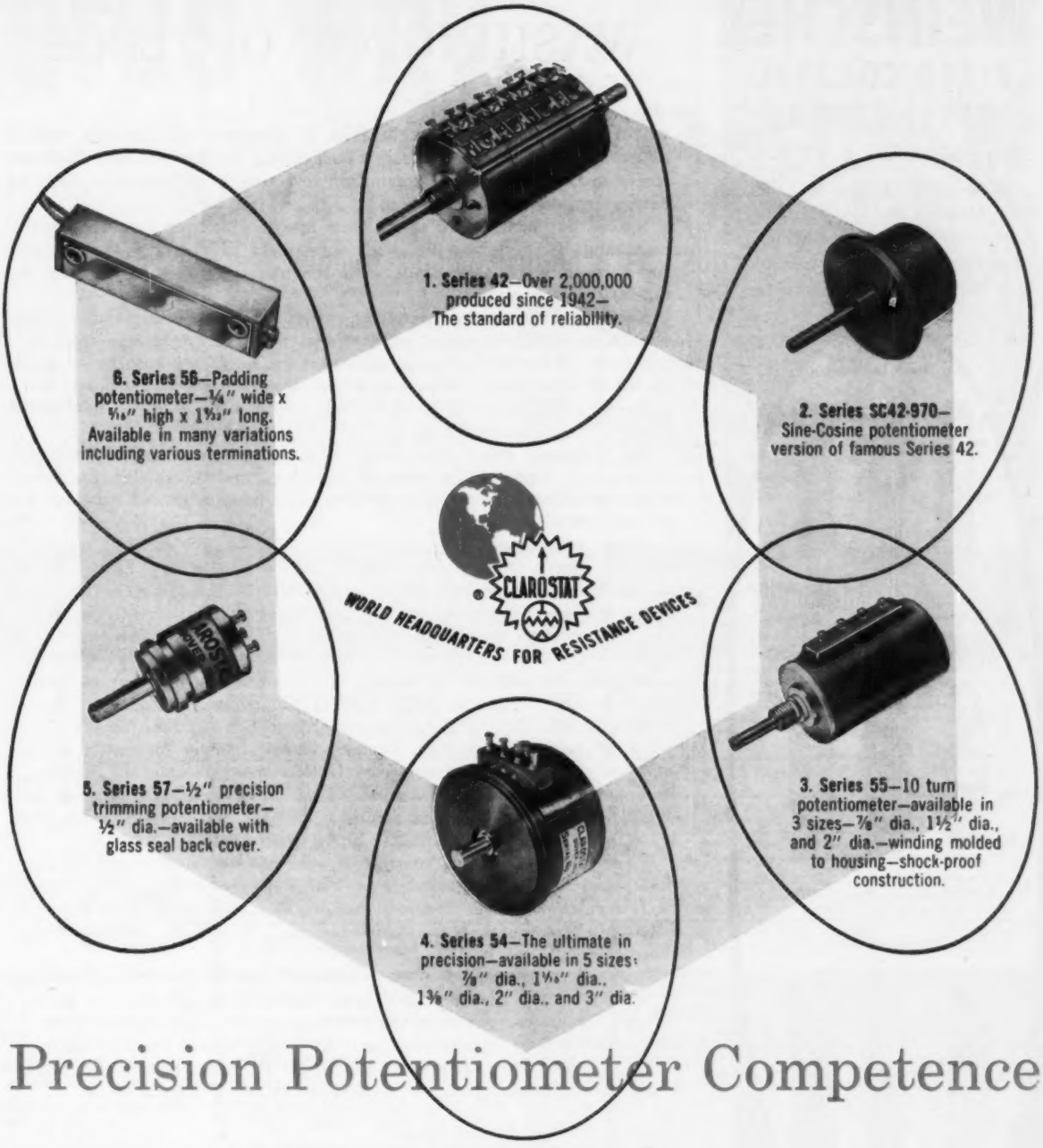
MELBOURNE—Miniature phase sequence detector smaller than a matchbox has been developed here by engineers of the Sydney County Council to replace several larger types now in use. The new device was designed for 415 v operation, uses miniature neon tubes and a capacitor in place of incandescent lamps and inductors. The very low power requirements of the neon tubes allow the use of miniature resistors and a very small capacitor. All components are in a transparent epoxy resin, making the device rugged and waterproof.

In operation, one neon tube glows brightly while the other is extinguished. Letters next to the tube indicate the phase sequence.

U. S. Firm's Subsidiary Expanding in Britain

LONDON—Honeywells Controls, Ltd., wholly owned subsidiary of Minneapolis-Honeywell Regulator, has disclosed plans for a $2.8-million expansion program for its industrial instrumentation facility in Lanarkshire. The three-year investment program, financed in equal parts by the British board of trade and Honeywells, will boost the labor force from 2,000 to 3,000, will double capacity.

A former textile mill at Reddish, near Manchester, has been acquired by General Electric Co. Ltd., for changeover to a semiconductor production facility. The new installation will have a working space of 600,000 sq ft.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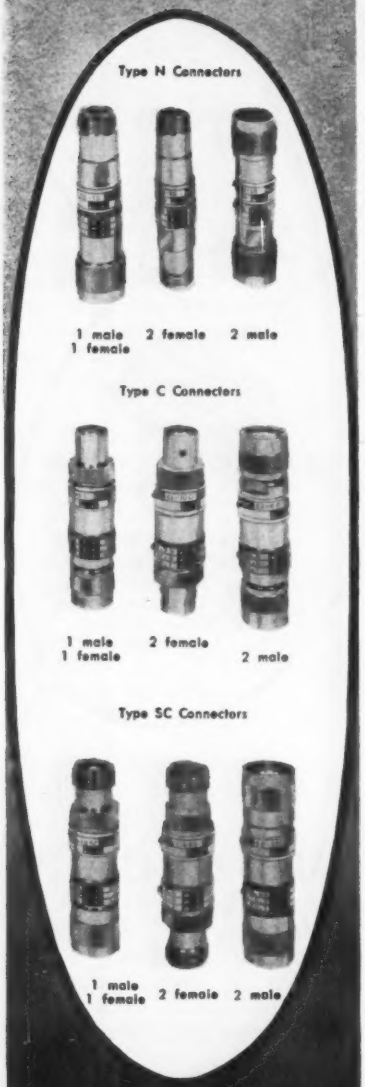

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WASHINGTON OUTLOOK

VICTORY of President-designate John F. Kennedy will have a marked effect on the electronics industry's burgeoning military market. Kennedy comes to the White House committed to boosts in defense spending and reorganization of the Pentagon.

Spelled out in industry terms, this means a heavier rate of procurement and R&D contracting, with consequent greater defense business for electronics. It also means some important changes in the way the military does business.

Kennedy will want to expand the size of U. S. retaliatory strike forces and to modernize so-called conventional forces to fight limited brush-fire wars. Judging from campaign oratory, he is thinking about accelerated production of Minuteman and Polaris missiles, a continuous airborne alert for B-52 bombers, more hardened sites for land-based ICBMs, and development of new bomber aircraft.

His proposals would also mean increased procurement of jet-troop-carrier and cargo planes, tactical missiles, combat vehicles, battlefield communications equipment, small arms, and more advanced weapons for ground troops.

In his campaigning, Kennedy called for a $2.5-billion to $3-billion boost over the current $41.5-billion military spending level. But he's vague as to whether this is to be a dramatic, one-shot increase in the budget, to be leveled off in following years; regular large incremental rises each year as proposed by several independent study groups; or a long-range increase over the next couple of years.

Actually, Kennedy has not immersed himself in specific program details, has leaned heavily in his defense-policy pronouncements on Sen. Stuart Symington (D., Mo.) and his running-mate, Lyndon Johnson.

On defense reorganization, Kennedy wants stronger unification of the services. He's aiming at a reorganization "on the basis of function." Presumably, this would not mean abolishing the individual services, but would involve creation of new strategic, tactical, and logistic forces, each made up of Army, Navy, and Air Force components.

If carried to its logical conclusion, this scheme would result in more centralized control over procurement and R&D contracting. There would be fewer military field agencies authorized to deal with industry and, inevitably, fewer numbers of firms invited to bid in negotiated-type contracting.

But don't expect any immediate changes. Kennedy's narrow margin of victory reduces his ability to carry out his ideas in a hurry. On the issue of defense reorganization, for instance, he faces the stubborn opposition of Rep. Carl Vinson and Sen. Richard Russell, the two Georgia Democrats who are chairmen of the House and Senate Armed Services Committees. Both oppose major changes in the Pentagon setup.

AT THE FEDERAL COMMUNICATIONS COMMISSION, it's tough to judge what changes if any the Kennedy administration will make. Only one appointment will open in the near future; it will replace Charles H. King, Republican dean of the Detroit College of Law, who is serving out the unexpired term (until June 1961) of John C. Doerfer, who quit as chairman last July.

The issues which have caused the most controversy at FCC have not been approached on party lines. Political liberals often express belief that all tv should be switched to uhf, for instance; but the leading proponent of uhf is Republican Robert E. Lee, who has been confirmed for a second term on the Commission.

A current uhf experiment in New York will bring this issue to a head in a couple of years. The other big question FCC faces is pay-tv, which has not been a partisan issue.

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	PADT-27	Mixer, oscillator or converter, 455 or 262.5 kc; at 6 or 12 volts.	Low mixer noise averaging only 3 db at 1 mc. Low leakage, less than 50 μa at 60°C.
MOBILE COMMUNICATIONS	PADT-25	High frequency IF amplifier in mobile communication and airborne receivers.	Unusually high output resistance for improved receiver selectivity. Less than 50 μa leakage at 60°C improves AGC operation.
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	h_{fe} (f=1 kc)	40 min 150 typ	80 typ	RF 20–80 CONV 20–200 IF 20–100
	f_{max} (mc)	262(2) typ	—	50 min
	P_c (mw at 45°C)	67	60(3)	30
	I_{CBO} (25°C)	8 μa max 1.5 μa typ	7 typ	10 max
RF	Maximum Available Power Gain 1.5 mc	47.5 db(4)	47.5	—
IF	Maximum Available Power Gain 455 kc	30.5 db(4)	34.5 db	30

(1) Calculated on the basis of $f_{max} = 50$ mc and $r_b C_c = 200$ $\mu\mu$s substituted in the following equation: $f_{nco} = f_{max}\sqrt{8\pi r_b C_c}$
(2) Calculated value based on a maximum available power gain of 28 db at 10.7 mc and a power fall of 6 db per octave.
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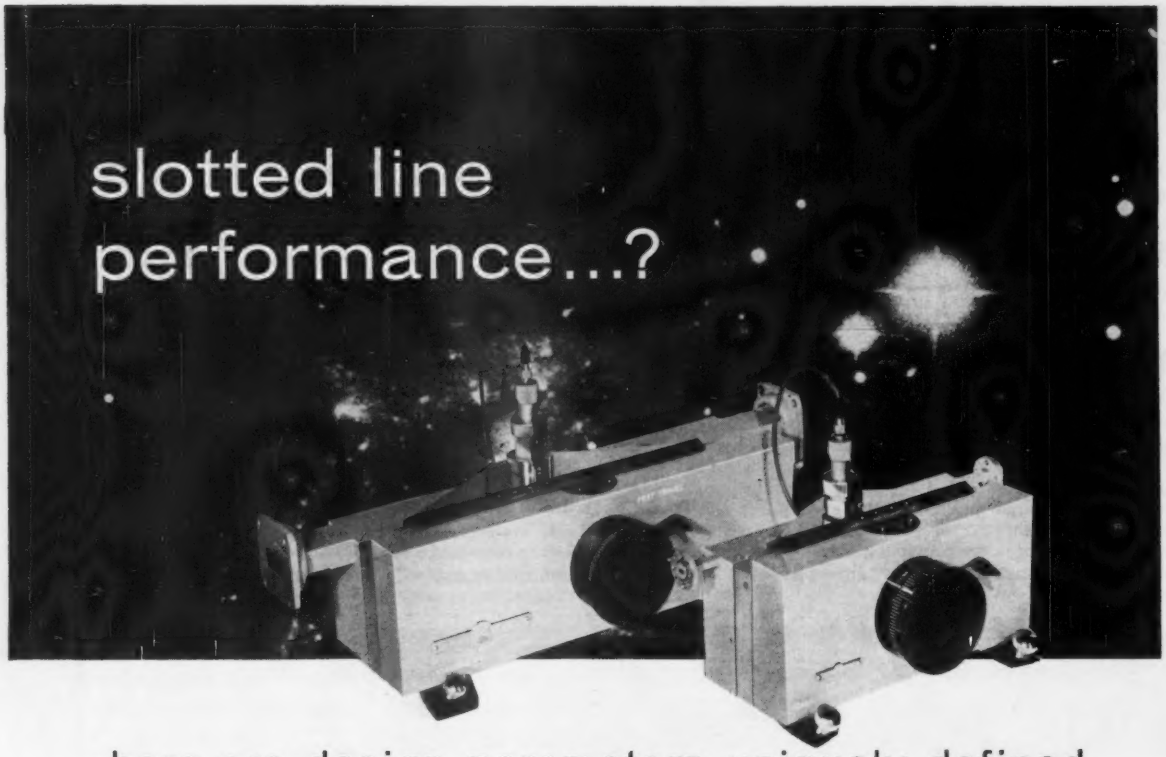

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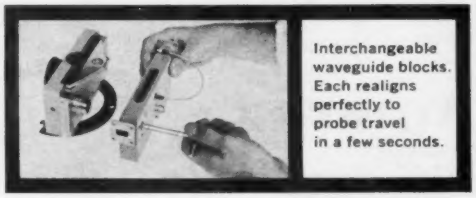
For complete data, see your D-B Catalogue, or request folder DB-825.



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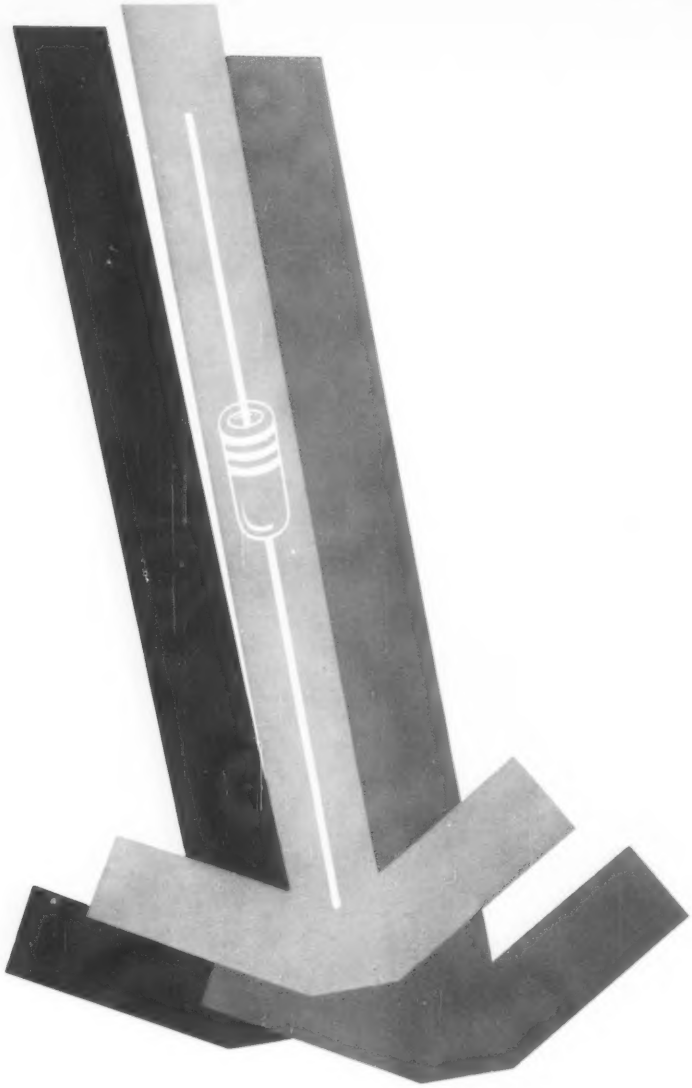

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MILITARY TYPES

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1N458	MIL-E-1/1027	1N663	MIL-E-1/1140
1N459	MIL-E-1/1028	1N658	MIL-E-1/1160
		1N643	MIL-E-1/1171

Write for Bulletins B217A-1, B217A-2 and B217-4.

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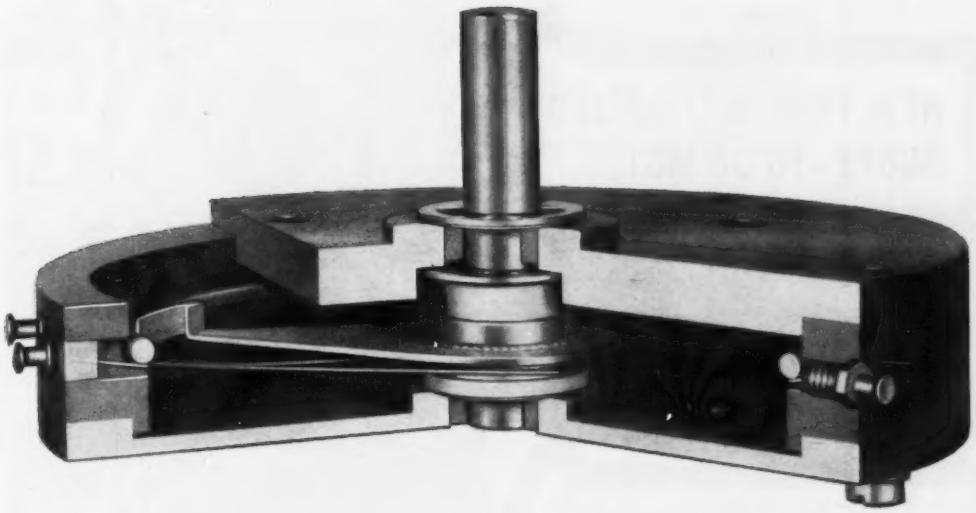


Then put it to the test!

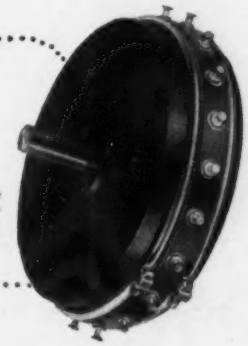
This blow-up of the unique GAMEWELL High Pressure Spring Contact Potentiometer Design tells the story. It's shockproof, shake-proof, foolproof!

Precious metal spring contacts with unit pressure in excess of 10,000 pounds per square inch assure *positive, troublefree* contact at both tap and terminal. This advanced High Pressure Spring Contact Design provides extremely *low end resistance . . . without* excessive linearity distortion at taps. In addition, pressure is well within the spring's elastic limit . . . and there are none of the fatigue factors inherent in welded joint construction. It's truly a *long-life* design . . . and meets MIL specifications.

Thousands of GAMEWELL Pots incorporating this High Pressure Spring Contact Design are operating in all kinds of service. Exhaustive GAMEWELL and user tests have confirmed the superiority of this design under severe environmental conditions of shock and vibration . . . over temperature ranges from −65°C to +200°C. Put this method to the test in your lab.

For applications requiring utmost dependability, specify GAMEWELL High Pressure Spring Contact Design. Write for additional information and send specification requirements to THE GAMEWELL COMPANY, 1382 Chestnut Street, Newton Upper Falls 64, Mass. *A Subsidiary of E. W. Bliss Co.*

GAMEWELL Series RL-270A Potentiometers are available with High Pressure Spring Contacts. They also feature dimensionally stable housings, closer tap spacing, advanced design shaft-and-slip ring for low noise and minimum wear.



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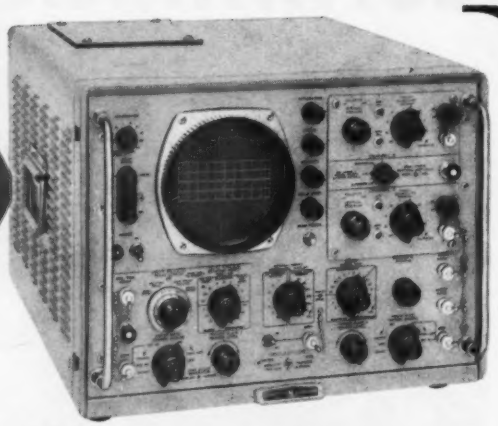
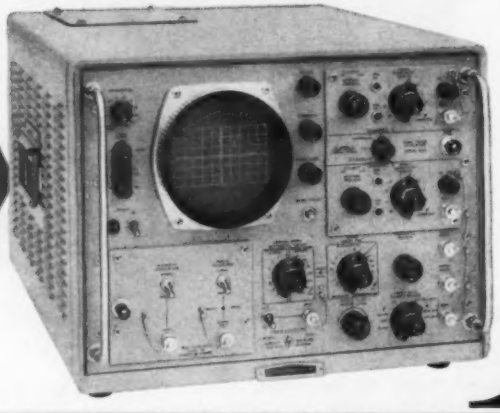
CIRCLE 19 ON READER SERVICE CARD 19

NEW FROM hp Highest reliability Highest quality

NEW 170A MILITARIZED SCOPE–TO 30 MC!



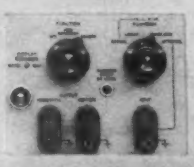
hp 160B MILITARIZED 15 MC SCOPE!



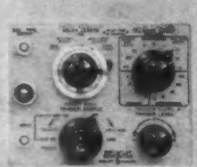
Vertical, time axis plug-ins provide unique

166A Plug-in (Time-Axis) furnished with the -hp- 160B and 170A Oscilloscopes (as pictured), provides standard input connections, including trigger input, Z-axis, single-sweep arming input.

162A Dual Trace Amplifier plug-in (vertical) gives maximum sensitivity to 20 mv/cm, permits viewing of two phenomena simultaneously, offers differential input for common mode rejection, meets environmental requirements of MIL-E-16400C. Electronic chopping permits better utilization of sweep speeds, extends simultaneous viewing of 2 signals to lower frequencies without flicker. -hp- 162A, $350.00



166C Display Scanner (Time-Axis plug-in) provides output to duplicate, on an X-Y recorder, any repetitive waveform appearing on CRT trace. Resolution with permanent, large-scale records is higher than either scope CRT or photograph, and you can observe the scope trace while records are made. Unit converts high speed signals to slower signals having the same waveshape; scanning speed is arranged to keep Y_1 output within the bandwidth of conventional recorders. -hp- 166C, $900.00.



166D Sweep Delay Generator (Time-Axis plug-in) delays the main sweep of the 160B and 170A Scopes for detailed examination of a complex signal or pulse train. In addition, it offers a unique mixed sweep feature to show an expanded segment of a delayed waveform while still retaining a presentation of earlier portions of the waveform. Delay time 1 μsec to 10 sec. Delaying sweep 18 ranges. Delayed length 0 to 10 cm. Delay functions: trigger main sweep, arm main sweep, mixed sweep. -hp- 166D, $325.00.

CIRCLE 20 ON READER SERVICE CARD

OSCILLOSCOPES

Meets military specifications
Conventional controls for simple operation
Uniquely versatile dual plug-ins providing:

1. **X-Y records of repetitive waveforms**
   (hp 166C Display Scanner Plug-in)
2. **New sweep delay convenience**
   (hp 166D Sweep Delay Generator Plug-in)
3. **Widely versatile input capabilities**
   (hp 162A Dual Trace Amplifier Plug-in)

These are the scopes you have been waiting for! Built to exacting military specifications, they offer instantly expandable measurement capability—*when you need it.* It's easy! Just add a moderately priced plug-in unit!

Both hp 160B and 170A employ the same vertical and time-axis plug-ins providing the widest range of application with minimum plug-ins and minimum investment. Details of these plug-ins are given on the opposite page.

New hp 160B and 170A follow MIL-E-16400C for shock, vibration, humidity and temperature. Important features include high stability tube-transistor circuits, regulated dc filament voltages and premium components throughout. Power transistors in efficient heat sinks insure cool operation; etched circuits on translucent epoxy glass simplify circuit tracing and servicing.

Simple, conventional controls speed set-up time and actual measuring. Improved preset triggering insures optimum operation for almost all conditions with just one adjustment—even on signals down to 2 mm deflection. Both hp 160B and 170A give you big, bright presentation on a 5" CRT, with a clear, steady trace free from bloom or halo.

A push-button beam finder automatically locates off-screen beam or trace (especially useful for operation by inexperienced personnel). And to increase general-purpose usefulness: 24 calibrated sweep times, 0.1 μsec/cm to 5 sec/cm, ± 3% accuracy. Vernier extending slowest sweep to 15 sec/cm. Seven-range magnifier increasing fastest sweep to 0.02 μsec/cm. Horizontal sensitivity 0.1 v/cm to 10 v/cm. Vernier extending minimum sensitivity to 25 v/cm. hp 160B, $1,850.00; hp 170A, $2,150.00.

versatility for the hp 160B and 170A scopes!

SPECIFICATIONS—hp 160B and 170A with hp 166A Plug-in

VERTICAL

Bandwidth:	hp 160B, 15 MC hp 170A, 30 MC
Voltage Calibrator:	9 calibrated ranges ± 3%, 0.2 mv to 100 v peak to peak
Current Calibrator:	5 ma peak to peak ± 3%

HORIZONTAL

Bandwidth:	dc to 1 MC
Sensitivity:	7 ranges 0.1 v/cm to 10 v/cm. Vernier extends minimum sensitivity to 25 v/cm
Input Impedance:	1 megohm shunted by 30 pf

SWEEP GENERATOR

Internal Sweep:	24 ranges, 0.1 μsec/cm to 5 sec/cm, ± 3%. Vernier extends slowest sweep to 15 sec/cm
Magnification:	7 calibrated ranges, X1, X2, X5, X10, X20, X50 and X100. Increases fastest sweep to 0.02 μsec/cm
Triggering:	Internal, power line or vertical input signal (2 mm or more vertical deflection); external (½ v peak to peak or more)
Trigger Point:	Positive or negative going voltage. Trigger level of external sync signal adjustable —30 to +30 volts
PRICE:	hp 160B, $1,850.00 (cabinet or rack mount) hp 170A, $2,150.00 (cabinet or rack mount)

Data subject to change without notice. Prices f. o. b. factory.

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Blue Jackets are ideal for use in miniature electronic equipment with either conventional wiring or printed wiring boards.

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Earnings Up for Texas Instruments

EARNINGS AND SALES for **Texas Instruments** in the third quarter of this year are up over the equivalent period of 1959. This year's sales figure is $54,096,000, compared with $46,700,000 last year. Net earnings after income taxes were $3,596,000 or 91 cents a share of common stock after preferred dividends, compared with $3,572,000 or 89 cents a share for the third quarter of 1959. Common shares outstanding total 3,924,613, compared with 3,914,630 at the same period last year. Nine-month sales and earnings this year were $170,147,000 and $11,517,000 respectively, compared with $140,899,000 and $9,877,000 for the first nine months of 1959.

Narda Microwave Corp., Mineola, N. Y., for the quarter ended Sept. 30 reports sales of $590,788. After payment of federal and other taxes of $220,422, and other expenses, net income from operations totaled $20,771, giving a net income per share of 35 cents.

Hoffman Electronics Corp., Los Angeles, announces net sales of $14,723,910 in the third quarter of this year, and $38,659,4) for the first nine months of 1960. This compares with $11,915,968 for the third quarter of 1959 and $34,261,157 for the first nine months last year. Earnings for the third quarter this year were $129,377, or 8.5 cents a share. Figures were higher in the same period last year with earnings of $459,661, or 30 cents a share. Net income for the first three quarters this year also dipped to $252,431, or 17 cents a share, as against $1,565,366 or $1.04 a share for the comparable 1959 interval.

National Research Corp., Cambridge, Mass., announces a net profit of $70,988 after taxes, equivalent to 13 cents per share of common stock, for operations in the third quarter ending Sept. 30. Company officials say the result brings the net profit after taxes for the first nine months of 1960 to $170,278, or 32 cents per share. In 1959, there was a profit of $49,970 in the third quarter, a net loss of $50,564 for the first nine months.

Hathaway Instruments, Denver, Colo., reports consolidated net sales for the nine months ended Sept. 30 were $9,364,492. Net earnings for the period were $672,024, equal to 70 cents per share, an increase of 28 cents per share over the 42 cents reported at the end of the preceding six-month period.

Electronic Research Associates, Cedar Grove, N. J., announces sales rose 33 percent during the company's first fiscal quarter ended August 31, to a figure of $568,023. Net profits were $43,600, more than double last year's $19,800 on sales of $424,839. Earnings this year were 23 cents a share as against last year's 16 cents a share.

25 MOST ACTIVE STOCKS

WEEK ENDING NOVEMBER 4, 1960

	SHARES (IN 100's)	HIGH	LOW	CLOSE
Gen Tel & Elec	1,277	26⅜	24¾	26⅜
Lockheed	886	26½	23⅝	25¼
Ampex	730	23	20⅝	20⅞
Avco Corp	688	14⅛	13¼	13⅞
Gen Electric	688	77⅜	71⅝	77¼
Sperry Rand	674	19¾	18⅜	18⅞
Int'l Tel & Tel	631	40¼	37⅜	39⅞
North Amer Av	601	43⅞	41⅝	43⅛
Westinghouse	508	48⅝	46⅛	48½
Martin Co	387	55½	52½	54½
Philco	385	19⅝	17¾	18¾
Gen Dynamics	350	38⅞	36½	38½
Varian Assoc	344	43¾	39⅞	43½
Univ Controls	341	15⅛	14⅜	14¾
Texas Inst	331	171½	157	171⅛
Zenith Radio	327	105	99¼	99⅝
Elec & Mus Ind	292	6¼	6	6¼
Litton Ind	267	75⅞	70½	74⅞
Gen Instrument	266	34⅜	32	33¼
Polarad	246	19½	17⅝	18¾
Beckman Inst	243	82½	76½	81¾
Cenco Inst	229	48½	43	47¼
Federal Pac Elec	205	17½	16½	17½
Burroughs	202	29¼	28⅛	28⅞
Collins Radio	197	45	42⅛	43¾

The above figures represent sales of electronics stocks on the New York and American Stock Exchanges. Listings are prepared exclusively for ELECTRONICS by Ira Haupt & Co., investment bankers.

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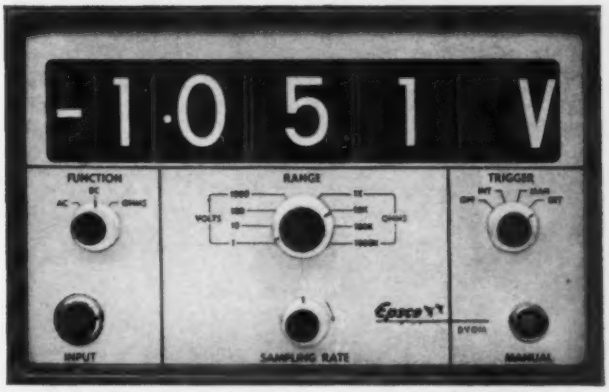
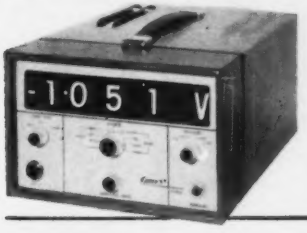


EPSCO DVOM® COMBINES 9 FEATURES IN 8¾" x 5¼" x 13¾"



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- AC and DC voltages from 0 to 1000 (four ranges)
- Resistance: 1K to 1000K (four ranges)
- Accuracy: DC – 0.1% AC – 0.25% Ohms – 0.25%
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6. In-line, in-plane display.
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Take pivots, for example, which support the rotating armature of a meter movement. Because Simpson quality standards are so high, Simpson makes its own pivots which require more than 60 separate inspections during manufacture. Among these are 100% inspection under a 100X microscope and sampling inspection under a 400X microscope to check radius, cone angle, finish and other characteristics. One result is pivot points with a radius tolerance maintained to within .000010". Moreover, Simpson inspects each and every group of pivots for correct hardness so they won't deform under rough use.

Through such meticulous care as this, Simpson is able to offer you panel instruments with accuracy limits that are 100% guaranteed . . . instruments with conservative ratings on which you can rely . . . instruments that *stay* accurate . . . instruments you can specify with confidence.

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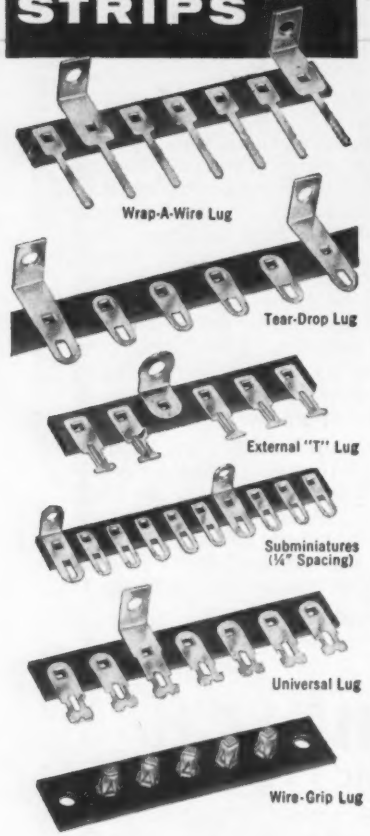

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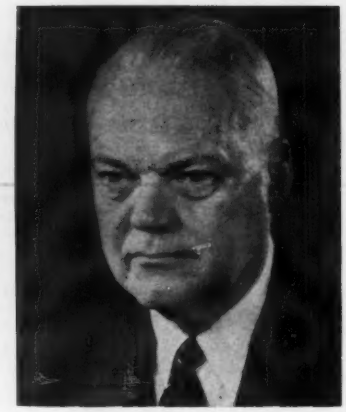
Henry J. Dempsey, Deputy Director, Trade Development Division, Bureau of Foreign Commerce: "Opportunities are more extensive"



Bradley Fisk, Assistant Secretary of Commerce for International Affairs: "World markets in the 1960's present formidable challenges"

New Look at World Markets

IN RECENT TALKS before American business executives, Department of Commerce officials Henry Dempsey and Bradley Fisk (above) have underscored the opportunities that exist today in the international market for sales of electronic equipment. Information reported to management executives by Dempsey is of particular note because of the detailed market opportunities he outlines for various countries. For instance:

UNITED ARAB REPUBLIC—Given populous conditions and sufficient dollar exchange, an extremely wide range of United States products could be sold here. Tv transmitting and receiving materials are one of the products he lists as having good credit market possibilities.

DENMARK—Hospital and surgical equipment, which is becoming increasingly electronic, Dempsey says, is one of the products for which there is good export market here today. He also says there is a growing market for phonograph records and scientific instruments.

FRANCE—A recent survey reveals a wide range of export possibilities and that many items could double their present sales rate. One class of products with good export possibilities is machine tools (for which electronic controls are becoming of increasing importance.)

Dempsey reports that lack of publicity material in France limits expanded sales of electric-electronic medical products.

LUXEMBOURG — Despite its small size (population 320,000), this country is a good market for many products because its limited population has made it impossible for Luxembourg to be self-sufficient.

Among the products believed to have good export possibilities are: Duplicating machine (a field in which electronic types are winning an increasing share), and electronic data processing machines.

NETHERLANDS—Widest possibilities for U. S. exports appear to be for goods with desirable characteristics which the Dutch cannot get elsewhere—such as, labor saving devices and equipment. These are in demand due to the labor shortage.

LEBANON—Good markets exist for scientific instruments, phonograph records, automatic telephone equipment (becoming increasingly electronic) and for a simultaneous translating system.

NEW ZEALAND—U. S. exports to this country have increased sig-

nificantly in the past few months due to the virtual removal of discriminatory import licensing. However, a considerable further increase is still possible, Dempsey says. Items with current export possibilities include:

Television set components, transmitting equipment, paper machinery and machine tools (two items in which electronic controls are playing an increasing role.) There is also a latent demand for communication equipment and office machinery of all kinds.

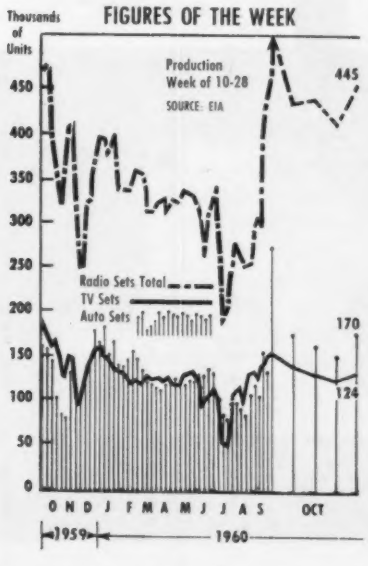
Bradley Fisk points most of his attention to the national need to improve our export levels in order to meet our large and growing expenditures of foreign goods, now $15 billion annually.

Growth in these expenditures is a basic necessity for international relations. Copy of Fisk's remarks can be obtained from the U. S. Department of Commerce by asking for Challenge of World Markets, Oct. 17, 1960.

Among details he mentions is the fact that many countries outside of Europe have largely abolished or reduced dollar discrimination.

These countries include Australia, Malaya, Japan (one of the largest importers of electronic products in the world.)

Fisk adds that this year it is anticipated there will be the virtual elimination of discrimination against U. S. goods abroad.



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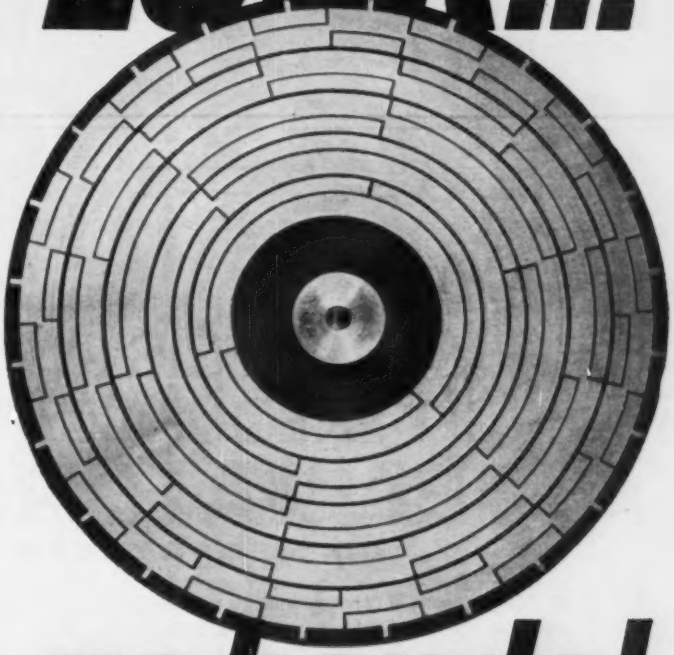
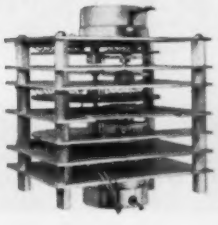


no hands!

This printed circuit disc is the "face" of a clock that tells time in digital code

. . . or any code your computer, control system, or data processing device needs to keep it properly in touch with the world of real time.—A. W. Haydon is a company of infinite variation when it comes to such analog-to-digital converters, or "binary encoders". Time periods range from seconds to weeks. Sizes range from miniature to large. They come sealed, enclosed or open, with AC, DC, or pulse drive, and with an imposing variety of accessory equipment.—The model shown is for commerical use. It provides a discrete signal for each two-minute interval over a 28-day period. It is used, among other places, in an automatic parking lot ticket computing system.—This and several other time code generators are described in Technical Brochure SP9-2. It's yours for the asking. Similar solid-state devices can be supplied by our Culver City, Calif., facility.



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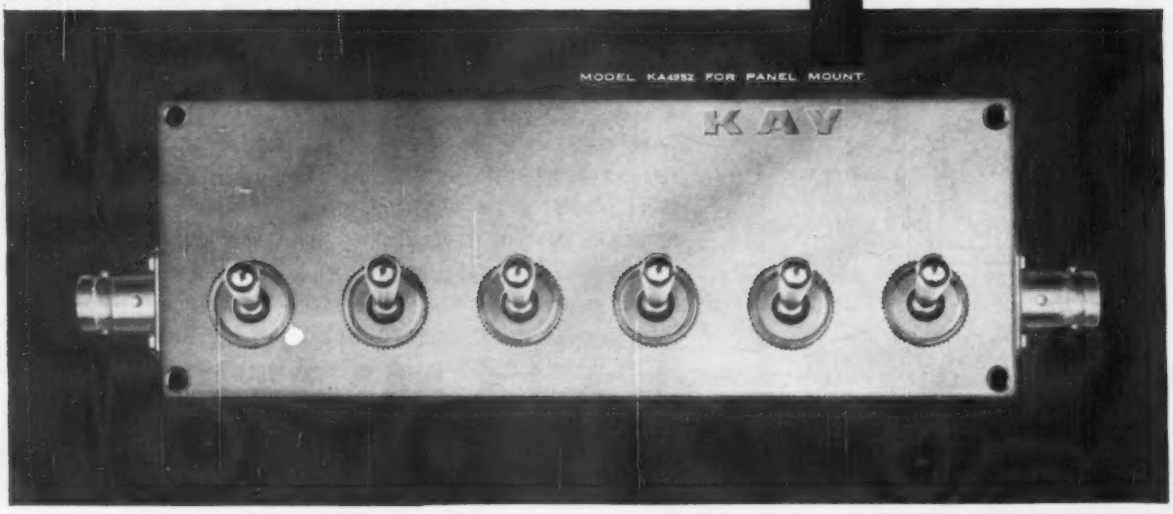

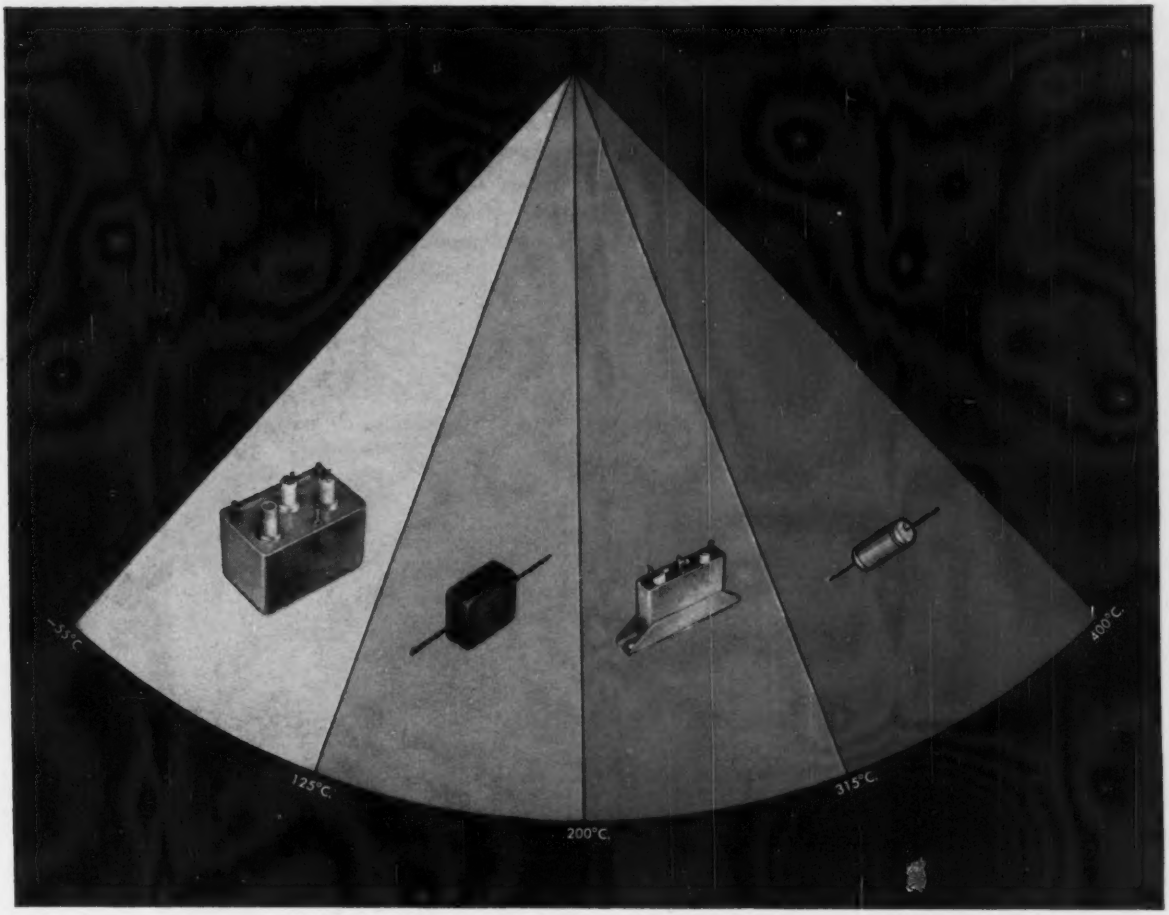

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Environmental resistance **Wide voltage range** **High I. R.** **Radiation resistant**
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Under 125°C.—Specials
• Size and weight reductions at high voltages • Drift—.25% capacitance change typical from −55°C. to +125°C. • High I. R.—1500 megohm X microfarads typical at 125°C. • Solid impregnants—no liquid leakage.

125°C. to 200°C.—Available soon
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200°C. to 315°C.—In production
• .05 to 4.0 uf, 600 V and up • Drift—3% capacitance change typical from −55°C. to +315°C. • High I. R.—10 megohm X microfarads typical at 315°C. • Nothing smaller at 315°C.

315°C. to 400°C.—In development
• .001 to 6.0 uf, 150 V and 600 V • Drift—5% capacitance change typical from −55°C. to +426°C. • High I. R.—1 megohm X microfarad typical at 400°C. • Prototype availability • Only inorganic materials used.

For full details, write:

Scintilla Division
Sidney, New York

THE Bendix CORPORATION

New Random Access Memory Package...

uses only 18.75"
IN STANDARD 19" RACK

GENERAL CERAMICS, continuing its leadership in the memory packaging field, has made available double and triple bay random access memories with up to 4096 characters x 32 bits per character at cycle times up to 6 micro-seconds. Now you can get design economy since the basic G-C package requires only 18.75" of standard rack space—a reduction of up to 80% over typical units requiring a full six feet.

General Ceramics offers space-saving random access memory designs with varying number of characters, word lengths and logic.

Optional design features include parity checking, test cycles, indicator lights and power supply locations.

Write on your company letterhead for additional information.
Please mention your requirements; address inquiries to Section E.

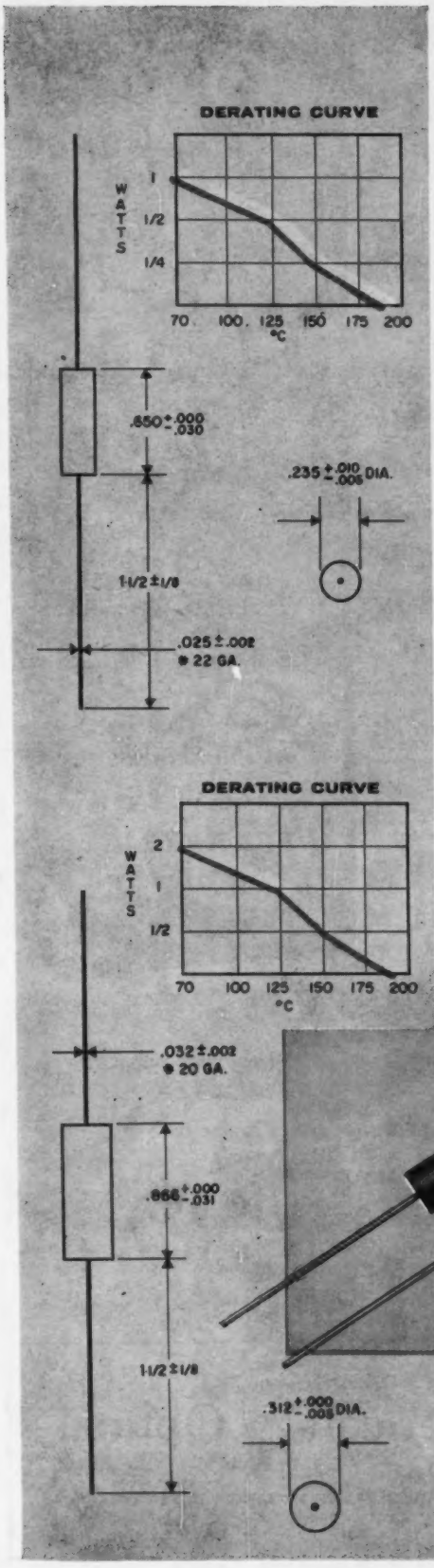
DIVISION OF INDIANA GENERAL CORPORATION

APPLIED LOGIC DEPARTMENT

GENERAL CERAMICS

KEASBEY, NEW JERSEY, U.S.A.

TECHNICAL CERAMICS, FERRITE AND MEMORY PRODUCTS



ONLY WESTON VAMISTORS® OFFER SMALLER SIZES, HIGHER RATINGS, EXTENDED RANGES

1/4-watt and 1/2-watt size resistors give double ratings in ambients of 125° C

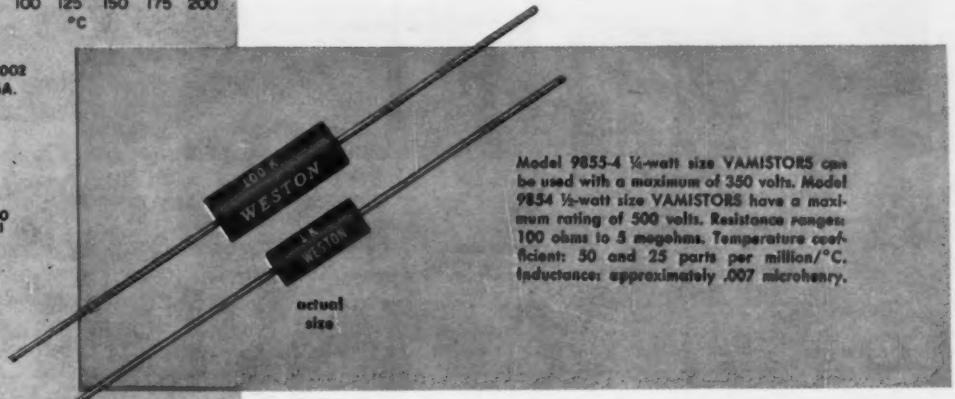
Miniaturized Weston VAMISTORS provide the desirable features of wire-wound and film-type resistors, yet offer higher wattages and superior thermal characteristics. For example, standard ¼-watt size "Missile Line" VAMISTORS are rated at half watt, and ½-watt sizes give a full watt at 125° C. Gas-filled "Missile Line" units thefore offer *twice* the wattage ratings of standard VAMISTORS!

Design advantages include high stability, low temperature coefficient, and tolerances of ±1%, ±.5%, ±.25%, and .1%. These new precision film resistors are virtually noise free, have extremely low inductances, and are available with resistances up to 5 megohms.

High reliability is assured, since Weston VAMISTORS are subjected to more rigid quality standards than *any other type* of resistor. They meet or surpass all applicable MIL specifications.

For special applications, pairs or sets of VAMISTORS can be matched to tolerances of ±.025% or temperature coefficients of ±5ppm of each other, or combinations of both tolerance and temperature coefficient.

Call your Weston representative for full information, or write for Catalog 04-101. Daystrom, Incorporated, Weston Instruments Division, Newark 12, New Jersey.
International Sales Division, 100 Empire St., Newark 12, N. J.
In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 19, Ontario.



Model 9855-4 ¼-watt size VAMISTORS can be used with a maximum of 350 volts. Model 9854 ½-watt size VAMISTORS have a maximum rating of 500 volts. Resistance ranges: 100 ohms to 5 megohms. Temperature coefficient: 50 and 25 parts per million/°C. Inductance: approximately .007 microhenry.

DAYSTROM, INCORPORATED
WESTON INSTRUMENTS DIVISION
Reliability by Design

Here's why the NEW AO TRACE-MASTER is the world's finest 8-channel direct writing recorder!

American Optical Company, famous for precision instrumentation for 138 years, introduces an electronic direct-writing recorder of unique design, in which ultra-precise electromechanics has been combined with advanced electronics to achieve *truly superior performance.*

Finest Writing Method Ever

Unique direct-carbon-transfer writing method. Trace is uniformly black and up to four times thinner than that made by any other recorder. Minute variations in phenomena measured are more faithful, meaningful. Carbon trace cannot fade... may be easily reproduced.

Finest Frequency-Amplitude Performance

TRACE-MASTER'S multiple-feedback wide-range Driver circuitry, combined with the advanced pen-motor design, produces wider frequency response *at larger amplitudes* than any other recorder. TRACE-MASTER response is flat—*within 1%*—from dc to 110 cps at 40 mm!

Band Amplitude Product (i.e. Bandwidth times Amplitude) is 5600...140 cps (3 db point) x 40mm!

Finest Chart-Drive Facilities

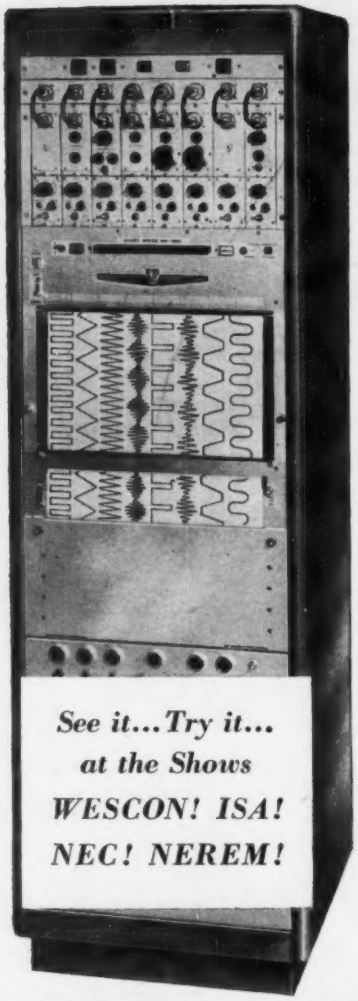
TRACE-MASTER provides widest chart-speed range...0.1 to 500 mm/sec...of any direct-writing recorder! Convenient push-button selection. Take-up reel automatically stores full 1000 ft. record. Writing table tilts for easy chart annotations. Guide rails permit quick, easy paper-roll changes. Low cost chart paper makes practical protracted recording at high speeds.

Finest Resolution, Linearity, Stability

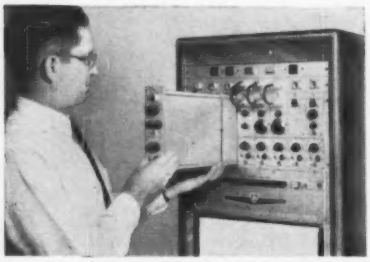
Thin carbon trace (thinner by 4 to 1 over most recorders) and high Band Amplitude Product (higher by 6 to 1 over other recorders) provide up to 24 times the resolving power or ability to detect short, sharp variations in the record. The superior linearity (± 1%) and stability in rectilinear presentation permit full use of this unexcelled resolution.

Finest Systems Oriented Compatability

Fully transistorized circuitry...application of combined dc level and signal multiple feedback...complete interchangeability of modular signal-conditioning elements... are some of the features that make the AO TRACE-MASTER the world's finest 8-channel direct writing recorder.

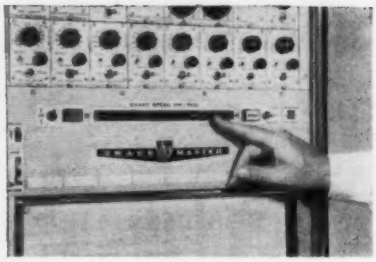


See it...Try it...
at the Shows
WESCON! ISA!
NEC! NEREM!



Entire channel easily accessible and completely interchangeable as single unit.

Platen tilts to convenient writing angle.



Widest range chart speed . . . push-button selection through 0.1 mm/sec to 500 mm/sec.

WRITE, WIRE, TELEPHONE TODAY FOR COMPLETE INFORMATION!

Complete Engineering Bulletins available.
Field Sales Engineers at your service everywhere.

American Optical
COMPANY
INSTRUMENT DIVISION, BUFFALO 15, NEW YORK

appearances are not deceiving

THIS P&B 10-AMP RELAY IS AS RELIABLE AS IT LOOKS

Our AB relay looks rugged . . . and it is. You can specify it for 10 amp switching and confidently expect 100,000 cycles. Yet it is compact, easily mounted, and does not require special handling. Installation is simple, using your preference of screw terminals (adapters), quick connects, or dip soldering.

Designers specify the AB for air conditioners and other products where dependable, continual service is paramount.

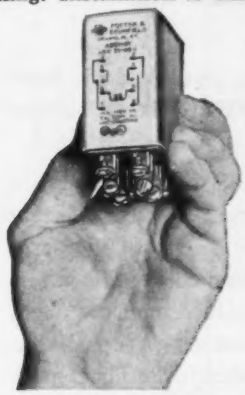
These standard AB and ABC relays are listed by Underwriters' Laboratories and Canadian Standards Association:

Type	Arrangements	Type	Arrangements
AB7AY	DPST-NO	ABC7AY	DPST-NO
AB8AY	DPST-NC	ABC8AY	DPST-NC
AB11AY	DPDT	ABC11AY	DPDT

Coil voltages: 6, 12, 24, 115 and 230 volts AC, 50/60 cycle.
Contact rating: 10 amps, 115 volts AC or 5 amps, 230 volts AC noninductive.

U/L File E-29244 CSA No. 15734

Write for complete data or contact your nearest P&B sales engineer.



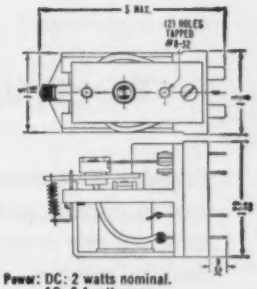
ABC Series—AB series can be supplied enclosed in sturdy metal dust cover, 1³¹⁄₆₄" x 2²⁵⁄₃₂" x 2³⁄₃₂".

AB AND ABC RELAYS ENGINEERING DATA

GENERAL:
Insulation Resistance: 100 megohms minimum.
Life: 3 million cycles (mechanical).
Breakdown Voltage: 1500 volts rms between all elements and ground.
Temperature Range: DC: −55 to +45°C.
AC: −55 to +45°C.
Weight: AB—5 ozs. ABC—7 ozs.
Terminals: Fit ¼" quick-connect terminals, or may be applied to printed circuits using dip soldering. Screw adapters furnished on request.
Enclosure: ABC: Heavy duty dust cover.
Dimensions: 1³¹⁄₆₄" x 2²⁵⁄₃₂" x 2³⁄₃₂".

CONTACTS:
Arrangements: DPDT
Material: ¼" dia. silver. Other materials available.
Load: 5 amps at 230 volts AC or 10 amps at 115 volts AC noninductive.
10 amps at 28 volts DC.

COIL:
Voltage: DC: 6 to 110 volts.
AC: 6 to 230 volts.



Power: DC: 2 watts nominal.
AC: 6.4 volt-amps.
Resistance: 35,000 ohms max.
Duty: Continuous: DC coils will withstand 6 watts at +25°C.

MOUNTINGS:
AB: Two 8-32 tapped holes on 1¼" centers.
ABC: One 8-32 stud ⅝" long and locating tab.

P & B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR

POTTER & BRUMFIELD

DIVISION OF AMERICAN MACHINE & FOUNDRY COMPANY, PRINCETON, INDIANA

IN CANADA: POTTER & BRUMFIELD CANADA LTD., GUELPH, ONTARIO

DOW | THERMOSETTING RESINS

Complex pre-preg boards like this get dimensional stability from **DOW EPOXY RESINS**

Complex electronic circuit boards, especially those used in aircraft, computers, missile and rocket systems, are now being made stronger, more heat and chemical resistant—with greater over-all dimensional stability – using copper-clad, glass cloth laminates impregnated with Dow epoxy resin.

Noted for their flexural, impact and copper bond strengths, Dow epoxy resins give copper-clad, epoxy/glass laminates excellent dimensional stability—even during dip soldering. Shrinkage, warpage, twist rarely occur. What's more, they score very high in acid and solvent resistance, heat and humidity tolerance. And Dow epoxy resins process easily, won't support fungus growth, and will not change measurably with age.

The complicated board shown—laminated with Dow epoxy resin – is so thin it can be rolled into a tube for shipping, or twisted to fit an oddly contoured assembly, if necessary, without damage. For full information and technical assistance on Dow epoxy resins, write: THE DOW CHEMICAL COMPANY, Midland, Michigan, Plastics Merchandising Department 1978JG11-18.

See "The Dow Hour of Great Mysteries" on NBC-TV

THE DOW CHEMICAL COMPANY • MIDLAND, MICHIGAN

Bell's All-weather Automatic Landing System—symbolized.

CLEARED TO LAND, WEATHER OR NOT

Today's increasing air traffic demands faster and safer all-weather operation at every airport.

Bell brings this goal one important step closer with its All-Weather Automatic Landing System (ALS) which can fly two airplanes to touchdown every minute, even when visibility is absolutely zero.

The Bell ALS takes over when the pilot brings his plane through the electronic "window in the sky" and guides it to a safe and sure landing.

The system has been flight-proved in more than 4,000 landings with all types of aircraft—small private planes as well as airliners from the DC-3 and DC-7 to the huge Boeing 707 jet. It now is being evaluated at FAA's National Aviation Experimental Center, Atlantic City, N. J.

Unlike other automatic landing systems, the Bell ALS is ground-based so a ground observer monitors every approach and landing. It can operate either fully automatically or under pilot control.

Military versions of the ALS have been ordered by the Air Force. The Navy has selected it for installation aboard the nuclear-powered aircraft carrier USS Enterprise as well as for its other large carriers.

The Bell ALS is but one among many contributions which Bell Aerosystems Company is making to the scientific progress and defensive strength of the free world. We invite qualified engineers and scientists to inquire about sharing our challenging and rewarding future.

BELL AEROSYSTEMS COMPANY
BUFFALO 5. N. Y.
DIVISION OF BELL AEROSPACE CORPORATION
A TEXTRON COMPANY

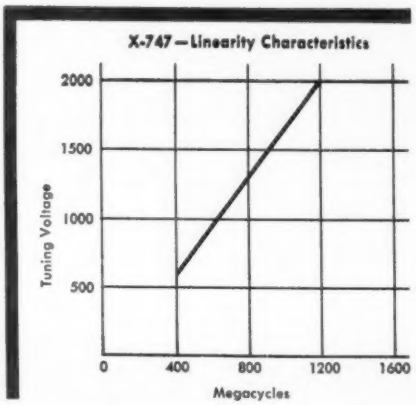
CIRCLE 35 ON READER SERVICE CARD

wide range voltage-tunable magnetron from Eimac

Take a look at the world's most advanced voltage-tunable magnetron: Eimac's new X-747, shown here with its magnet and cavity. This new tube can be tuned over the exceptional range of 400-1200 megacycles—a range approached by no other electronically tunable device. And it's extremely linear! Nominal output power of the X-747 is 100 milliwatts.

And too, the X-747 is easier to use than any similar device. No complicated heater voltage regulation is needed. Back heating is eliminated through its exclusive indirectly-heated matrix cathode plus advanced electron injection design. And heater power supply can be *either* AC or DC.

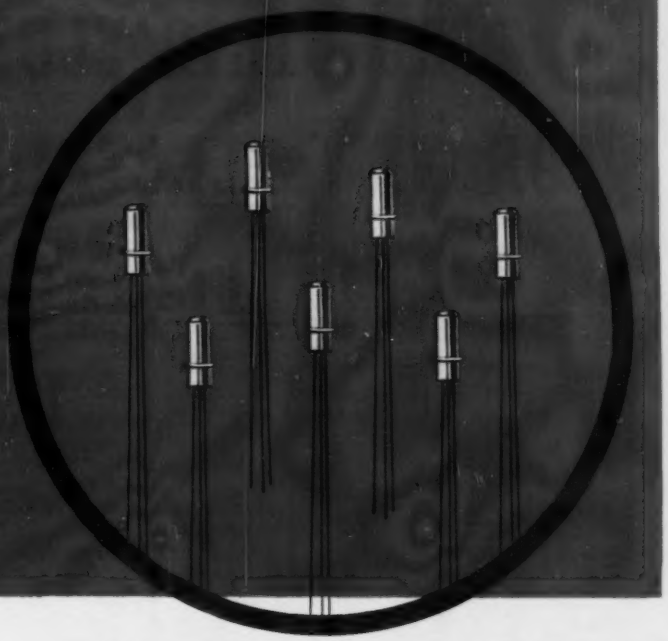
These advances make possible the most reliable voltage-tunable magnetron available today. Eimac can readily develop and produce other VTM types to meet *your* specific needs. For full information, write: Microwave Product Manager, Eitel-McCullough, Inc., San Carlos, California.



MICROWAVE TUBES • AMPLIFIER KLYSTRONS • NEGATIVE-GRID TUBES

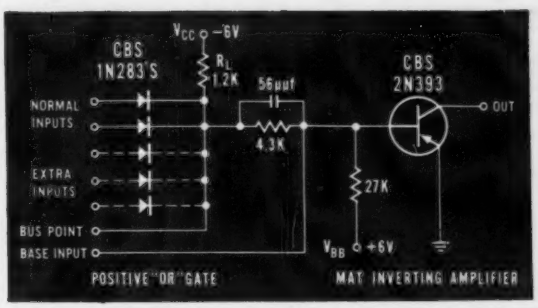
CBS

MAT* TRANSISTOR CUTS COMPUTER COSTS UP TO 25%



The CBS 2N393 MAT transistor cuts computer costs three ways: *Transistor costs* . . . this transistor far outperforms ordinary alloy switching transistors — and at lower cost, since fewer are required. *Component costs* . . . the versatile 2N393 simplifies circuits, eliminates many expensive components. *Manufacturing costs* . . . the high-performance 2N393 makes possible a universal, simplified circuit that permits full exploitation of standardization economies. *Total savings* can easily amount to 25%.

Check the CBS 2N393 features and characteristics . . . and the universal computer circuit shown. Order engineering samples from your local Manufacturers Warehousing Distributor or sales office.



UNIVERSAL MAT CIRCUIT PERFORMS 80% OF COMPUTER FUNCTIONS

This basic NOR circuit provides for more than 80% of the logic and storage functions of moderately fast data processing systems: AND gate, OR gate, inverter, and flip-flop. Advantages include economy, reliability, and ease of replacement. Special features are: minimized noise sensitivity and power dissipation . . . worst-case design . . . operating temperatures to 55°C . . . max. input of 22 collectors and diodes . . . repetition rate up to 1 mc.

CBS 2N393 FEATURES

- High gain with high frequency response
- D-c beta linear up to 50 ma
- More efficient high-injection emitter
- Low saturation resistance adaptable to DCTL
- Pyramiding factor of 5 easily attained
- Exceptional uniformity through controlled base width
- Welded TO-24 case hermetically sealed
- Automated production with sequential quality control
- Over-all quality exceeding MIL-S-19500

CHECK THESE DATA

Maximum Ratings

Junction temperature, °C	85
Collector voltage, v	−6.0
Collector current, ma	−50
Dissipation at 45°C, mw	25

Electrical Characteristics (25°C)

Max. I_{CBO} (V_{CB} = −5v), μa	5
Min. h_{fe} (V_C = −3v, I_E = 0.5 ma)	40
Min. h_{FE} (V_{CE} = −1v, I_C = −50 ma)	20
Max. V_{CE} Sat (I_C = −8 ma, I_B = −1 ma), v	0.07
Max. V_{BE} (On) (I_C = −8 ma, I_B = −1 ma), v	0.5
Min. f max. (max. frequency of oscillation), mc	40

*Micro Alloy Transistor, trade-mark Philco Corp.

CBS ELECTRONICS, Semiconductor Operations, Lowell, Mass. • A Division of Columbia Broadcasting System, Inc.

Sales Offices: *Lowell, Mass.*, 900 Chelmsford St., GLenview 4-0446 • *Newark, N. J.*, 231 Johnson Ave., TAlbot 4-2450 • *Melrose Park, Ill.*, 1990 N. Mannheim Rd., ESterbrook 9-2100 • *Los Angeles, Calif.*, 2120 S. Garfield Ave., RAymond 3-9081 • *Atlanta, Ga.*, Cary Chapman & Co., 600 Trusco Way S.W., PLaza 8-4596 • *Minneapolis, Minn.*, The Heimann Co., 1711 Hawthorne Ave., FEderal 2-5457 • *Toronto, Ont.*, Canadian General Electric Co., Ltd., LEnnox 4-6311

From Monsanto FluiDesign Service...

DIELECTRIC FLUIDS FOR NEW ELECTRICAL AND ELECTRONIC USES

Monsanto can supply you with a series of dielectric liquids that offer the optimum combination of properties for liquid cooling and insulation. Many of the fluids described below are now used commercially in capacitors, transformers, "miniaturized" electronic packages, cables, amplifiers, solenoids, thermostats, computers, and circuit breakers.

Examples:

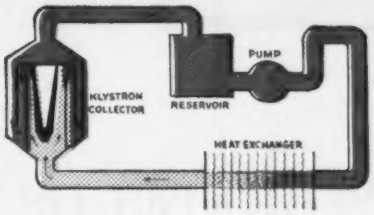
A. In electrical equipment such as transformers, Monsanto's askarel-type fluids offer a series of *fire-resistant* dielectrics. These fluids make a firesafe liquid-fill insulation for equipment that then may be located in operating areas without special precaution or costly shielding.

B. As impregnants for premium-quality capacitors, high dielectric Monsanto fluids permit a substantial decrease in capacitor size—about 50-60%—compared to oil-impregnated

Dielectric Fluids	OS-59	Coolanol® 35	Coolanol 45	Aroclor® 1221	Aroclor 1232	
Properties						
Dielectric Strength, 25°C, 60 cps, 0.1.	44KV	47KV	27KV	35KV	35KV	
Dielectric Constant, 25°C, 1000 cps	2.46 (10^6cps)	....	2.2 (10^6cps)	4.5	5.4	
Volume Resistivity, ohm-cm, 25°C	$6.7x10^{13}$	....	$9x10^{10}$	$>5x10^{12}$	$>5x10^{12}$	
Power Factor, % 1000 cps, 25°C	0.006 (10^6cps)	....	0.4 (10^6cps)	<0.1	<0.1	
Viscosity, CS −65°F	1380	934	2400	....	....	
100°F	6.8	6.5	12.2	4.6	6.9	
210°F	2.2	2.2	3.95	<1.8	<1.8	
Pour Point, °F	<−85	<−85	<−85	34	−32	
Boiling Point, °F 760 mm. Hg	>700	>600	>700	527	554	
Fire Point, °F Cleveland Open Cup . . .	435	430	430	349	460	
Thermal Conductivity Btu/hr/ft/ft²/°F	0.077	0.079	0.080	0.067	0.063	
Specific Gravity @25°/25°C	0.88	0.89	0.89	1.18	1.26	
Coefficient Thermal Expansion, per °F	0.00046	0.00047	0.00048	0.00039	0.00040	

capacitors. Because their dielectric constants are closer to those from the capacitor paper itself, they help achieve a more evenly distributed dielectric stress than is possible with mineral oil.

C. Monsanto's coolant-dielectrics dissipate heat and operate liquid-cooled power packs, magnetrons, traveling wave tubes, klystrons with precise temperature control. Liquid cooling with these dielectrics permits miniaturization of electronic components, conserves size and weight. These special synthetic fluids are



also lubricants, and the single fluid can double as the hydraulic-fluid activator for tuning mechanisms as well as the coolant for the electronic unit.

This schematic circuit (at left) shows how Coolanol 45 liquid cools a klystron. Pumped around the collector, Coolanol 45 absorbs surface heat from the tube wall and carries it away for dissipation in the heat exchanger.

Check the fluids shown for application in equipment you are using or developing. Monsanto can supply you with a dielectric fluid for virtually any electrical or electronic application, can be most helpful in guiding you in the early design stages of equipment that will require a liquid dielectric.

A sample of the fluids shown will be sent to you for evaluation on request. Please specify the particular fluid that interests you and state the nature of the application so that pertinent details can be sent you. For further information on available fluids, request a copy of FluiDesign Service's FLUID DATA FILE.

Simply write on your company letterhead.

Monsanto

Monsanto Chemical Company
Organic Chemicals Division
FluiDesign Service, Dept. 2766D
St. Louis 66, Missouri

	Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260	Biphenyl	HB-40	Santowax® R
	35KV	35KV	35KV	35KV	35KV	35KV	35KV
	5.8	5.6	5.0	5.0	2.5	2.65	2.58
	$>5x10^{12}$	$>5x10^{12}$	$>5x10^{12}$	$>5x10^{12}$	$>1x10^{12}$	$>5x10^{13}$	$>1x10^{13}$
	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	.... 17.2 2.5	.... 45.3 3.2	.... 46.4 6.14	 75	.... 0.98	.... 29 3.9	....
	2	20	50	88	156	−13	293
	617	644	689	714	491	683	687
	>610	>640	>662	698	255	385	460
	0.058	0.057	0.054	0.051	0.076	0.072	0.063
	1.38	1.45	1.54	1.62	0.984	1.002	0.955
	0.00038	0.00039	0.00037	0.00037	0.00050	0.00041	0.00052

Radar operator delivers film from AN/UPD-1 radar plane to processing van

SCOUTING BATTLEFIELDS

ANN ARBOR, MICH.—For the last seven years the Army has been turning some of the hottest advances in electronics to the problem of battlefield surveillance and target acquisition.

This effort, called Project Michigan, is going on at University of Michigan's Willow Run Laboratories. Work is contracted for through the Army Combat Surveillance Agency, a part of the Signal Corps.

Project Michigan deals with radar, infrared, acoustics, seismics and optics. It is a long-range project in engineering and the physical sciences aimed at satisfying Army requirements in search, detection, location and tracking; target analysis; information transmisson, processing, storage and display.

Special attention is given to all-weather, long-range, high-resolution sensory and location techniques, and evaluation of systems and equipment both through simulation and by laboratory and field experiments.

Armies of the future will be highly mobile and need rapid tactical transport and control of sensing devices. This has led to research in the navigation and guidance of aerial platforms.

Collection, transmission, reduction and collation of sensor data is a problem calling for modern data processing and display. Within the laboratories are an IBM 709 digital computer, Royal-McBee LGP-30 digital computer and large analog computer.

Eight Army-furnished aircraft —some of them modified into flying laboratories by Willow Run Laboratories—are used for research in airborne radar, infrared, telemetry, and navigation and guidance.

A high-resolution radar system, which Army generals and research scientists have called the most significant advance in radar since its invention, is a product of Project Michigan. Designated the AN/UPD-1, it takes detailed radar photographs from many miles away. The system is made up of conventional equipment.

The aircraft carries a radar with an antenna that looks to the side, radar signal-storage equipment, and a doppler-inertial system. A mobile van contains film-processing equipment.

The side-looking antenna of the radar scans a wide strip of terrain many miles away in a continuous operation. The returning pulses are continuously recorded on a signal-storage film, which constitutes the input to the ground-based analog computer. Radar signals on the film are translated into a detailed, distortion-free strip map upon which terrain and objects appear as if mapped from directly overhead, except for normal radar shadowing effects. Several strip maps can be combined to create a mosaic of a large area.

The AN/UPD-1, unlike conventional radar equipment, gives extremely fine resolution in azimuth at all ranges.

According to Willow Run Laboratories, range resolution is achieved by conventional pulsing, but the physical limitations on the size of an airborne antenna, and thus the limitations on the azimuth resolution, are overcome by the synthesis of a side-looking antenna many times larger than the aircraft. Just as a camera with a large aperture requires focussing to obtain a sharp picture, say the AN/UPD-1's designers, so too does a radar require focussing to get fine azimuth resolution. In the AN/UPD-1 the radar is automatically focussed simultaneously at all ranges.

A second radar system, designated the AN/TPD-2, is a 600-pound portable device designed to sweep enemy-held territory in a 25-mile semicircle.

Designed by the Project Michigan staff, this radar operates on the doppler principle.

The antenna is somewhat larger

Army C-46 modified to become a flying laboratory for surveillance

Here's a peek at what goes on in Army's Project Michigan. Shows how radar, infrared, acoustics, seismics and optics all help keep track of a battle. Computers, communications also play vital roles

OF TOMORROW

By WES PERRY McGraw-Hill World News

than those used on orthodox battlefield radar. This allows use of a low-frequency scanning signal that Willow Run Laboratories says has improved brush and foliage penetration.

Project Michigan is also working to improve passive infrared detectors and devices to provide surveillance at night as well as by day. Infrared research includes studies on detector materials and phenomena, including the use of a single-crystal of tellurium in a photoconductive detector, and reviews of scanning and imaging methods for improved resolution and intensity.

Fundamental research programs are pursued on the basis of their potential, if not immediate, contribution to combat surveillance and target acquisition activities. Included is the basic program in electron-spin resonance, out of which came the discovery of the properties of ruby as a maser material, with the prospects of devices for extremely low-noise amplification of faint microwave signals. A ruby maser radiometer is now being operated successfully on University of Michigan's 85-foot-diameter radiotelescope. Meanwhile, the Project is investigating the application of maser devices for surveillance.

Research has been conducted in acoustics and seismics because of their potential for all-weather, day-and-night surveillance. Reflectors, lenses, horns, and phased arrays of acoustic and seismic detectors have been studied. Basic studies of wave propagation and seismic signatures of signal sources are in process.

In optics and vision, past research under Project Michigan has centered around battle area illumination devices and visual aids, such as night binoculars, to extend the capability of the human eye in darkness and bad weather.

A laboratory simulation facility has been developed by Project Michigan to support its research activities in information processing the study of system concepts, and evaluation of concepts and equipment. Data processing equipment is used to simulate realistic surveillance-oriented tactical situations and environments. It also provides a means for scientific experiment and evaluation in many areas of surveillance prior to the availability of field equipment and without the expenses of actual field operations. Engineering psychologists at work on the Project use the laboratory simulation facility in their study and treatment of man-machine relationships.

Map of Washington, D. C., made by AN/UPD-1 surveillance radar

Transistor-Making Expands in Brazil

One local firm makes transistors under U. S. patents, one Dutch and one U. S. company are ready to move in. Four firms make electron tubes for expanding television set business

Assembling transistors at Elnabra S. A. in Sao Paulo

By LESLIE WARREN,
McGraw-Hill World News

RIO DE JANEIRO—Brazil's electron tube and semiconductor industry is a fast-growing $25-million business. Based on the rapidly expanding entertainment field, tube and semiconductor production has shot up from practically nothing in 1956 to over 10 million units this year.

So far this output has been used entirely within Brazil, but producers are now getting set to crack the export market, especially other Latin American countries. Lower-cost labor that can be readily trained plus the protectionist effect of Brazil's foreign-exchange regulations help promote local electronics manufacturing. The trend in imports, chiefly from the U. S., Netherlands and Japan, is down and probably will continue so, offset only partially by rising imports of manufacturing equipment.

Today four companies, all foreign based, manufacture electron tubes. The semiconductor producer is a Brazilian firm manufacturing to a U. S. patent, but two foreign-based manufacturers are getting ready to enter Brazil.

Tube manufacturers are RCA Victor S. A., S. A. Philips do Brasil, Sylvania and Standard Electrica, the latter confining production to power and tv picture tubes. Brazil's transistor and germanium diode manufacturer is Elnabra S. A. (Electronica Nacional Brasileira) in Sao Paulo. Elnabra's present output of 35,000 transistors a month will go to 100,000 by the end of the year. Philips and Philco are both about to start semiconductor manufacture in Brazil.

Elnabra closed a patent agreement with Raytheon in 1959 whereby the U. S. firm receives a 5-percent royalty, with an option to capital participation.

Two-year old Elnabra got into semiconductor manufacturing by first assemblying Raytheon-supplied parts; the firm now does alloying to make the collector and emitter junctions of the germanium crystal. Future plans include importing crystal-growing equipment. After this, it may become practical, company spokesmen say, to export transistors to the U. S.

Elnabra also makes ceramic capacitors, power transformers, transistor radios and electronic test equipment.

Standard Electrica S. A., wholly owned subsidiary of ITT, makes communications equipment for Brazil's telephone and radio industry, produces radios, tv sets and phonographs as well as tubes. The company has been making power tubes since 1945. Output is some 7,500 a year. Tube sizes range from 100 watts up to 60 Kw. Standard Electrica also makes picture tv tubes up to 21-inch at the rate of 6,000 a year for use in its own sets. About 50 percent of picture-tube parts are imported from the U. S.

Depending on size, from 15 percent to 85 percent of Standard's transmitting tubes are of local manufacture. A higher percentage of larger-size tubes is imported. Imports of tube parts consist chiefly of platinum, tungsten filaments, molybdenum, oxygen-free copper, plate nickel and the largest-size glass bulbs. The company has 1,800 workers at its new $1-million 250,000-sqm plant in Rio. Output can be expanded nearly one third. Company spokesmen say their power-tube and mercury-rectifier business has been expanding at an annual rate of 10 percent.

Sales of receiving tubes are up, spurred by a rapid growth in Brazil's television industry. Fifteen tv stations are on the air with more coming.

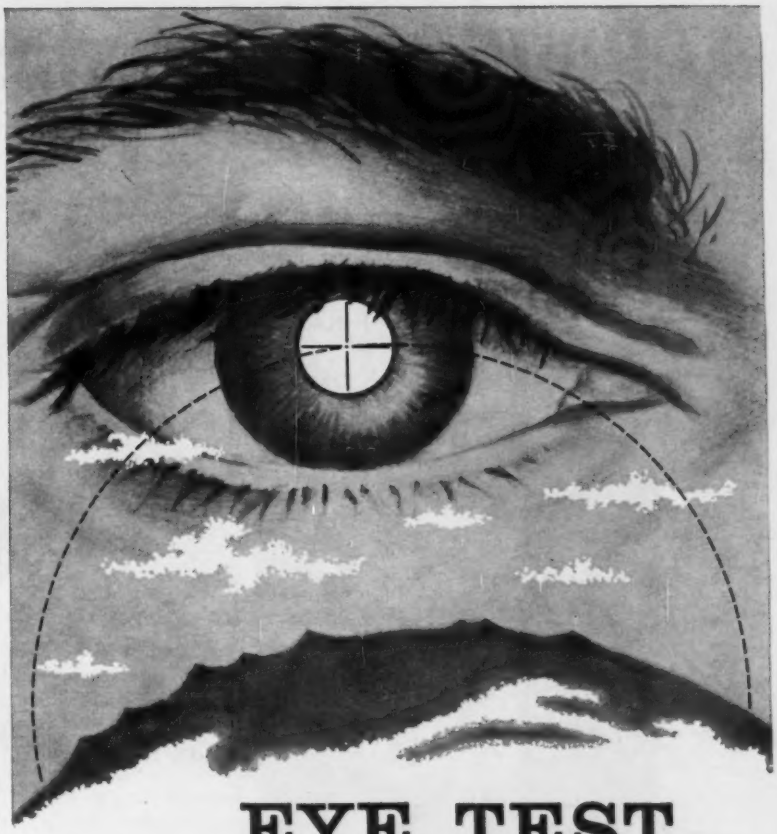
RCA Victor's Brazilian subsidiary now makes 150,000 receiving tubes a month, will step this up to 200,000 by year-end. The com-

pany imports filaments, plates, part of the cathodes for receiving and tv picture tubes, but makes its own glass and all other parts. Mica spacers are exported to the U. S.

RCA Victor's line includes beam power tubes, rectifiers, double diodes and triodes, double-diode triodes, pentodes and triode pentodes. Output from the plant in Belo Horizonte goes to other setmakers. RCA has abandoned local set manufacturing.

S. A. Philips do Brasil, the Dutch Philip's Brazilian subsidiary, makes a full line of receiving and tv picture tubes up to 21-inch through its two related Sao Paulo firms, IBRAPE (Industria Brasileira de Productos Eletronicos) and RADELSA (Radio e Electricidade S.A.) While getting ready to manufacture semiconductors locally, Philips has dropped prices on some types of imported transistors from approximately $1.20 a unit to 80 cents. This encourages local production of transistor radios by helping manufacturers meet competition from imported Japanese models, will in turn broaden the market for made-in-Brazil transistors.

Brazilian customs authorities have found it extremely difficult to control illegal import of low-priced Japanese transistor sets.



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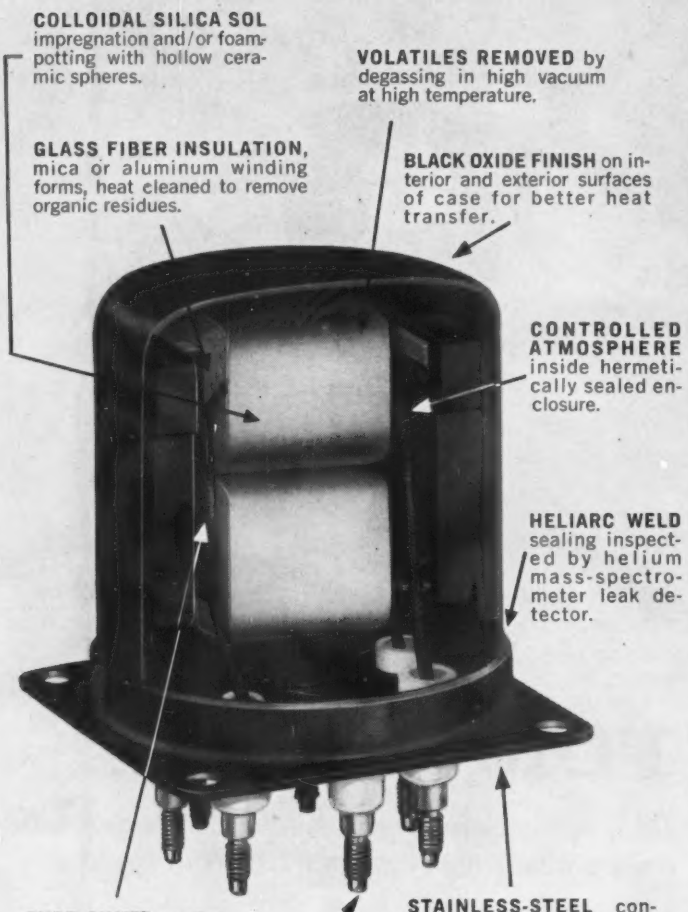
Raytheon Transformer Talk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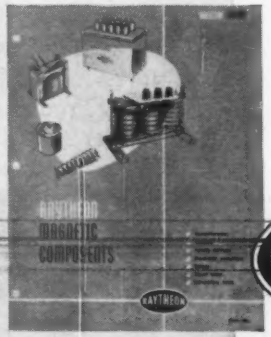
STAINLESS-STEEL construction of case and structural members for minimum weight.
ALUMINA TERMINALS protected against oxidation by special plating process.

WITHSTANDING DULL-RED HEAT CONDITIONS is one of the requirements for the new transformers now being developed at Raytheon. The nine construction features that make this possible are indicated above.

WRITE FOR 16-PAGE BOOKLET on Raytheon transformers or for specific help on your particular requirements.



New Raytheon transformer will resist nose cone temperatures to 1,100° F

Raytheon is now building transformers capable of withstanding temperatures such as those encountered in a re-entering missile's red-hot nose cone.

The unit pictured at left resists temperatures up to 1,100°F which is 700 degrees higher than units presently in use. The goal for units now under construction at Raytheon is a minimum operation time of 2,000 hours with an internal temperature 200 degrees above the ambient of 900 degrees.

To accomplish this, Raytheon has developed new construction techniques and high-temperature resisting wire and insulating materials.

For further information on high-temperature transformers please write, stating your specific requirements, to the address below.

RAYTHEON COMPANY
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Microwave & Power Tube Division
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In Canada, contact Raytheon Canada Limited, Waterloo, Ontario

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New Rule Spurs Microwave Market

BUSINESS MICROWAVE bids fair to become a new commercial field for our industry following last month's FCC decision to make a number of slots in the microwave band available to private users.

A check this week by ELECTRONICS shows microwave manufacturers believe the new market opened by the Commission will not explode into big sales volumes immediately, but rather will climb slowly as business microwave becomes a stable sales item.

Some manufacturers plan to approach this new market cautiously. They do not want to jeopardize their relationships with the common carriers who are now their best customers for microwave gear. The vice president of sales of a major eastern manufacturer told ELECTRONICS, "We'll have to put the two potential business volumes on a balance and see whether private users or common carriers will weigh most."

There are now some 3,000 private microwave stations according to Electronics Industry Association figures. By 1976, EIA predicts there will be about six times this number, representing close to $\frac{1}{2}$ billion in equipment.

Some companies are reluctant to comment on their plans to exploit the market, others say they have been anticipating the FCC move, are now almost ready in sales and manufacturing.

Motorola is planning to market its model MR-40 microwave system made for the 12-gigacycle region. Sales efforts will be conducted through the company's present sales network.

Plans to enter the market for business microwave are underway at General Electric according to a company spokesman. Additional personnel will be used to carry out these plans.

Raytheon's marketing manager for communications and data-processing equipment estimates the market for private microwave gear will grow from two to five times its present size within ten years now that restrictions have been relaxed.

Also keeping close tabs on developments is Collins Radio Co. A spokesman for the Cedar Rapids, Ia., firm says one growth area that may develop to important status is data transmission by private microwave. The company is stocking basic units.

Some manufacturers see additional sales possibilities for microwave components. Philco sees an important growth area in microwave for data processing relaying and counts on leasing equipment to stimulate market growth.

As a general industry pattern, manufacturers will build up modest inventories of microwave gear that will be held ready for installation of frequency-sensitive elements as orders are received.

One aspect in selling pointed out by company sales officials is the playing off of private systems against common carriers. "I won't be too surprised," said one sales manager, "if we find ourselves preparing complete layouts and proposals for a private installation and then find that the prospect will go to the common carrier and ask if they can meet or better the price we give."

When the decision was being hammered out before the Commission, general manufacturers were represented by the National Association of Manufacturers. NAM urged the Commission to set aside rulings that limited microwave ownership to common carriers, pipeline operators and railroads. Also urging a change was the Special Industrial Radio Services Association.

This group represents radio users in construction, mining and agriculture.

Support for letting down the bars came from the American Trucking Association, which sees microwave as the answer to linking cross-continent installations. Also testifying were the National Retail Dry Goods Association and the American Newspaper Publishers Association.

None of the above groups were eligible to use private microwave systems prior to last month's rule-making. However, support also came from groups that were already eligible to own their own microwave gear. Included were the National Committee for Utilities Radio, which represents the communications interests of public utilities companies; Petroleum Radio Services, whose pipeline operating members run a number of systems; and American Association of State Highway Officials. The American Bridge, Tunnel and Turnpike Association also gave its support to the change.

A member of FCC's legal staff told ELECTRONICS that no great difficulties are feared in the matter of interference. The main legal work in business microwave, according to the attorney will be formulating the fine points of the new program, which are now expressed in broad, general terms.

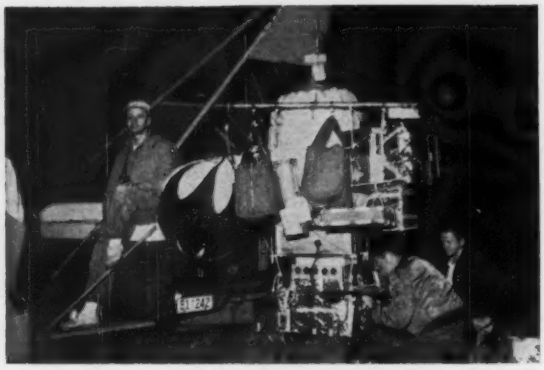
Digest of New Microwave Rulings as Spelled Out by FCC

(1) Microwave frequency bands 952-960 Mc, 1,850-1,990 Mc, 2,110-2,200 Mc, 2,450-2,500 Mc, 2,500-2,700 Mc, 6,425-6,575 Mc, 6,575-6,875 Mc, 8,400-8,500 Mc, 10,550-10,700 Mc, 11,700-12,200 Mc, 12,200-12,700 Mc, 13,200-13,250 Mc, 16,000-18,000 Mc, and 26,000-30,000 Mc are assignable to private users on the same eligibility basis as is now provided for mobile operations in the Safety and Special Radio Services.

(2) Nonavailability of common-carrier facilities is not a condition of eligibility for private usage of these microwave frequencies.

(3) Frequencies above 10,000 Mc only will be available for use in the Business Radio Service, except that the frequency band 952-960 Mc will be available for control-repeater operations in this Service and that the band 6,575-6,875 Mc will be available in this Service for intercity closed-circuit educational television, on a case-by-case basis when, apart from economic considerations, it is not feasible to use frequencies above 10,000

Measuring cerebral blood flow using radio-isotope technique developed at Veterans Administration Center.



Balloon-borne cosmic-radiation telemetry gear of USAF's Aeromedical Field Lab is checked prior to launch.

Analytic Methods Highlight Biomedical Show

By WILLIAM E. BUSHOR,
Associate Editor

WASHINGTON, D. C.—Research and analytical tools were the primary subjects of discussion at 13th Annual Conference on Electrical Techniques in Medicine and Biology held here recently. Special emphasis was given two comparatively new biomedical tools—computers, and nuclear magnetic resonance (NMR) and electron paramagnetic resonance (EPR) spectrometers. Also stressed were the better established areas of instrumentation, radiation studies and telemetry.

Use of NMR instruments to determine moisture and fat content of biological specimens, relaxation times of biological fluids, and chemical structures of biological materials was described by R. S. Codrington of Schlumberger Corp. He also indicated that double-resonance techniques in which both NMR and EPR are used could have application in analyzing complex molecules. In cases where the nucleus is in association with a free electron, an enhancement of the NMR signal of 660 times can be obtained.

Latest results of EPR investigation of biological and biochemical areas were discussed by B. Commoner of Washington University (see ELECTRONICS, p 86, July 29). Study of free radicals (molecules containing one or more unpaired electrons exhibiting magnetic effects) occurring in intermediate stages of a process have provided a new description of the chemical steps involved in enzyme-catalyzed oxidation of succinic acid. Also, free-radical concentration associated with physiological and disease conditions of tissue was noted. Tissue from obstructed bile ducts in the liver causing a form of jaundice shows a marked increase in free-radical content and is thus detectable by an EPR spectrometer.

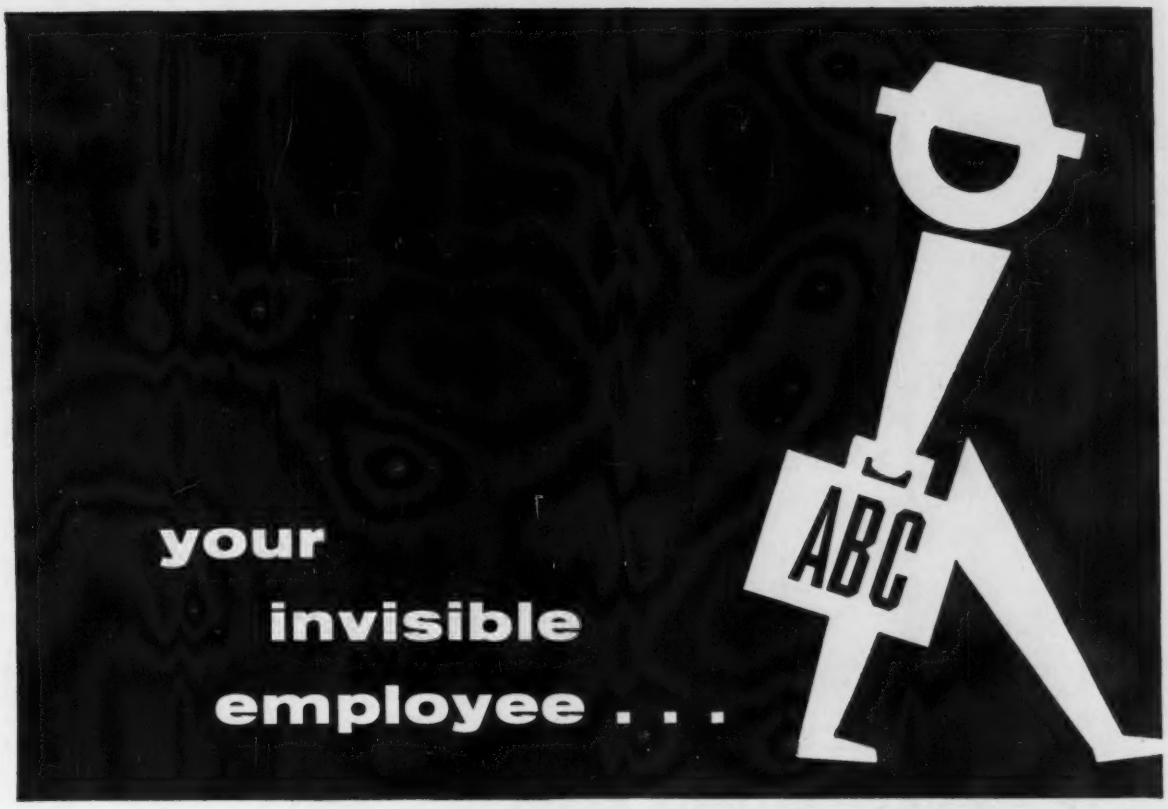
Several papers treated the ability of digital computers to reduce and analyze voluminous statistical information, synthesize biological models, analyze results of laboratory experiments, store and retrieve clinical and medical information, and perform routine calculations using the laws of physical science as applied to biological investigations. Also, pattern recognition and other analytical techniques in electrocardiography, electroencephalography and semiautomatic diagnoses were discussed. Analog and digital simulation of life processes received much attention.

A new organization, dubbed BIO, was announced for biomedical people who use or plan to use digital computers as tools. Greater exchange of information on computer applications and capabilities, and stimulation of use of computers in biomedical research are stated goals of the group.

Biomechanical properties of joints were discussed by R. J. Johns and V. Wright of Johns Hopkins University. Their work in measuring stiffness of a finger joint by means of strain gages attached to a special device for moving the finger, and an amplifier-oscilloscope combination to view the waveform produced by controlled movement of the digit was reported. Qualitive analysis unexpectedly revealed that, in diseased as well as normal joints, elastic and plastic stiffness were dominant, while contribution of viscous and frictional stiffness was relatively minor.

A high-power corona-type loudspeaker was described in a paper by E. Ackerman of Mayo Clinic and A. Anthony and F. Oda of Pennsylvania State University. The device produces high-intensity white noise in a 2-to-40-Kc region for studying stress effect of intense noise exposure on rodents. Sound is radiated directly from an a-f modulated r-f corona discharge at the apex of an air-filled glass horn. Experiments revealed that the thermal effect transmits periodic energy which produces a pressure change in the ambient air, creating sound.

Main components of the loudspeaker are shown in the drawing. A self-excited 28-Mc oscillator having 1.3-Kw output modulated by a 700-w modulator supplies the power. Water cooling is necessary to prevent melting of the glass by heat generated at the electrode tip. Exposed to high-frequency noise (2-to-40-Kc at 135 db) causes exaggerated adrenal activity in mice compared to low-frequency noise (150 to 4,800 cps at 139 db), and an increased



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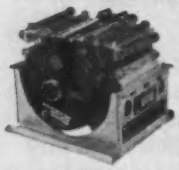

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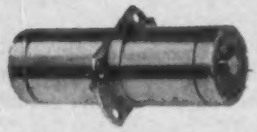

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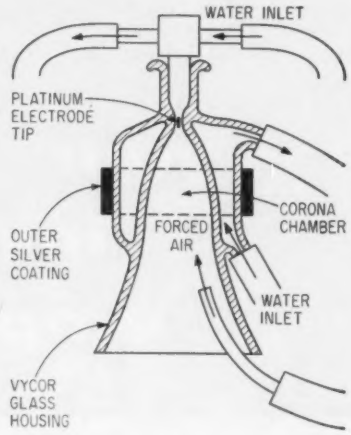
severity of abnormal behavioral reactions.

Experiments using radioisotopes injected intravenously and detected by a dual crystal-scintillation detection system to measure cerebral blood flow were described by W. H. Oldendorf of the Veterans Administration Center. It has been shown that although blood arriving at each hemisphere of the brain is approximately equal, the blood drains from the brain asymmetrically. Tests of 30 normal patients indicated that in most people the majority of the



Design of 1.3-Kw corona loudspeaker for generating high-intensity, 2-to-40-Kc noise

blood drains from the traverse sinus and out the right jugular vein. Some patients exhibited equal drainage, but none had majority drainage from the left side.

New instrumentation for measuring primary cosmic particles of low energy as well as the flux of electrons, protons, neutrons, alpha particles and gamma radiation found at high altitudes was described by Major Corkhill of the USAF Aeromedical Field Laboratory. A low- and high-energy counter together with associated photomultiplier, preamplifier, pulse-height analyzer, analog-to-digital converter and telemetry gear make up the system. This counting system can, on a real-time basis, detect, analyze and telemeter cosmic-particle data to receiving stations on earth, where biologically damaging radiation can be detected, analyzed and integrated into a dose rate. Also, total quantity of ionizing radiation space travelers might receive could be read.

Where Two-Color Tv Stands

It's remaining on the technological sidelines, according to report at EIA's Radio Fall Meeting

By GEORGE J. FLYNN
Associate Editor

SYRACUSE, N. Y.—For all practical purposes, two-color tv this week remains on the technological sidelines, where it was placed by a special subcommittee of EIA last December.

At the Radio Fall Meeting, held here recently, C. J. Hirsch, chairman of the subcommittee, reviewed the experimental and theoretical work in the area and explained why no recommendation was made for changes in the FCC color tv signal.

First, the picture produced by using only two colors is not as faithful a reproduction of the scene as is obtained with three colors, he said.

Second, he pointed out, a two-color tv receiver is not substantially cheaper than a three-color set.

Third, the FCC signal contains all the information necessary for monochrome, two-color and three-color reception, he said, and set manufacturers thus have the option of using any of the systems.

Those interested in testing two-color reception can do so by tying together two of the color guns of a standard three-color set. Engineers making the experiment report that viewers develop a growing distaste for the resulting picture. (Note: Methods of connecting the guns together will vary between the different types of sets.)

Other subjects of interest at the annual meeting, which is a major affair for those in entertainment electronics, included:

Stereo for tv and compatible stereo for a-m broadcasting, semiconductors for consumer products, multi-function receiver tubes and component reliability.

The 10-pin miniature tubes by Sylvania and the 12-pin Compactrons by GE are two approaches to cramming more circuit functions into the same envelope.

By adding one pin at the center of the standard 9-pin socket, double tetrodes, dual pentodes, triple triodes and other combinations are possible.

The 10-pin tube makes possible a 3-tube radio that is equivalent to the standard 5-tube unit; a black and white tv tube complement can be reduced from 17 to 13.

Larger envelope diameter, placement of the sealing nipple at the bottom, and a 12-pin connecting circle are features of the Compactron. Relocation of the exhaust nipple allows a height saving of $\frac{1}{8}$ inch but envelope diameter has been increased to $1\frac{1}{4}$ inch.

An advantage of the larger bulb is a general decrease in glass temperature when the new package is compared with the hottest of the tubes being replaced.

A 6GH8, for example, operates at a bulb temperature of 177 C and a 6AL5 at 50 C; when combined in the new package, bulb temperature is 137 C. From the examples presented in the paper, temperature trade-off or averaging appears usual.

Both the 10- and 12-pin types require fewer internal welds and fewer external connections; set manufacturing costs with the new designs are expected to be lowered, both in component cost and labor.

For the most part, the multi-function tubes will be particularly suited to the relatively easy circuits in radio and tv, while the problem sockets, such as the horizontal and vertical amplifiers, will still use single-function tubes.

Transistors, until now generally on the sidelines because of cost, are being carefully considered for home television. Several portable tv's have recently been announced but delivery will probably take several months.

An investigation into high frequency noise and gain figures of r-f transistors showed that these factors do not change independently of the static characteristics such as I_{CBO}, thus assuring satisfactory circuit operation during the usual life

ENGINEERING
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ON OTHER BENDIX
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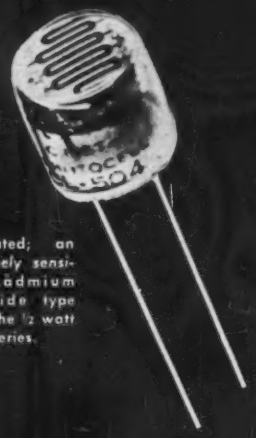

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of the transistor, and giving a simple check of component performance.

A proposed stereo system for tv was presented by Robert B. Dome of GE. The system transmits a Left plus Right audio signal from 50 cps to 15 Kc; $L - R$ is transmitted by double sideband about a suppressed carrier of 23.625 Kc; an extra pilot signal is also transmitted.

Frequency of the pilot signal is chosen as 39.375 Kc since this frequency can be generated easily at the transmitter and can be used at the receiver in combination with the available 15.75 Kc sweep signal to produce the 23.625 Kc suppressed carrier.

The choice of frequencies leads to a single tube de-multiplexer circuit at the receiver and in addition avoids ambiguity as to which signal is L or R.

Stereo effect is produced up to about 8 Kc; beyond this to audio cutoff both speakers have the same output.

Gear to Simulate Micrometeorites

GRUMMAN AIRCRAFT, under contract with the National Aeronautics and Space Administration, is engaged this week in the development of a method for imposing unusually high electrical charges on micron-size particles. The ultimate plan is to accelerate such particles electrically to velocities far in excess of those obtainable by any existing laboratory technique.

Charging will be accomplished by embedding protons in the volume of each particle through the use of a high-current, low-voltage proton beam. An important innovation in this work has been the development of a method for automatically confining the particles to the beam area during the charging period and subsequently extracting them from the beam.

The construction of a prototype charging system, which was started in May 1960, has been completed and the equipment is now in the initial phase of laboratory study in the Nuclear Research Laboratory at Grumman's Bethpage, Long Island plant. The design of the system was the result of a joint effort between Grumman and Radiation Dynamics Inc. The system was built by RDI.

The degree of charging attainable with this apparatus should be much higher than that attainable with ordinary surface-charging devices, being limited essentially only by the cohesive strength of the particle material, Grumman says. Although tungsten will be used as a convenient particle material in initial experiments, the use of iron, nickel and ceramic materials will be investigated in subsequent work.

The prototype charging apparatus was built under Grumman sponsorship, and will remain the property of the Grumman Co. The company will use the device for research on hypervelocity impact phenomena.

It is expected that such research will lead to more reliable estimates of the effects of micrometeorite impact on space vehicles.

More generally, detailed metallographic studies and measurements of crater formation in target materials are expected to yield significant data in the field of hypervelocity ballistics and penetration.

Satellite Tube

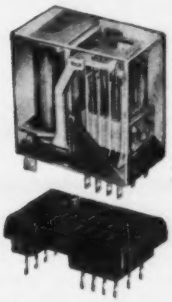
Traveling-wave tube for Bell System's satellite relay station amplifies signals as much as 10,000 times

ALLIED CONTROL'S

NEW LINE OF

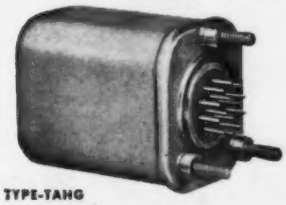
Sub-Miniature Telephone Type Relays

Now being manufactured entirely in the U.S.A., not only in its original West German design previously sold in this country by Allied Control Company, Inc. under an agreement with Siemens & Halske Company A.G. Germany but with variations to meet American requirements as well.



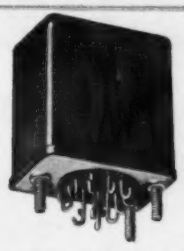
TYPE-T-134

H- 1 3/16 • W- 47/64 • L- 1 11/64



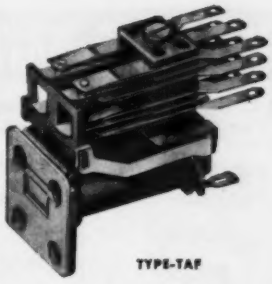
TYPE-TAHG

H- 2 3/16 • W- 1 7/16 • L- 1 5/8



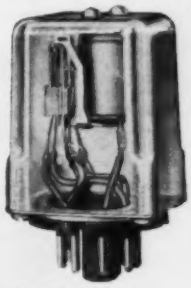
TYPE-TAH

H- 1 19/32 • W- 61/64 • L- 1 11/32



TYPE-TAF

H- 1 17/64 • W- 41/64 • L- 1 5/16



TYPE-TADO

H- 2 • W- 1 13/32 • L- 1 13/32

PERFORMANCE CHARACTERISTICS

Contact Arrangement
Up to 12 springs maximum form A, B or C

Contact Rating
2 amperes resistive or 1 ampere inductive at 29 volts d-c or 115 volts a-c
Low level or 5 ampere contacts available on request

Standard Coil Voltages
Suitable coil resistances can be supplied for operation at any voltage within the range of 0.5 to 130 volts d-c

Coil Power
Nominal: 700 milliwatts
Minimum Operate Power: 125 to 300 milliwatts depending on application, contact arrangement and coil resistance.

Timing at Nominal Voltage
Operate time: 15 milliseconds maximum
Release time: 5.0 milliseconds maximum

Vibration
10-55 cps at .062 inch double amplitude
55-500 cps at a constant 10g

Shock: 25g operational

Enclosure
Open, dust cover or hermetically sealed

Weight
Open type 1.0 ounce maximum
Sealed type 2.0 ounces maximum

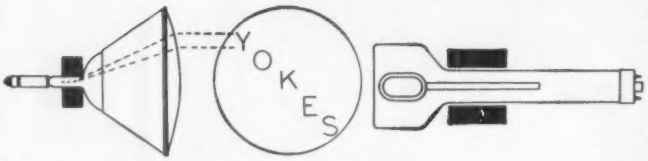
ALLIED CONTROL

ALLIED CONTROL COMPANY, INC., 2 EAST END AVENUE, NEW YORK 21, NEW YORK

Specialists in precision displays

Celco YOKES

Celco YOKES FOR CHARACTER DISPLAYS & HIGH RESOLUTION APPLICATIONS



Deflection yokes for difficult character displays and high resolution problems are another achievement in advanced design and engineering at Celco..

Celco Deflection Yokes permit rapid presentation of random character and alpha numeric displays. Low hysteresis, high accuracy and fast Recovery time with emphasis on spot approach to absolute zero, assures highest performance of magnetic deflection character displays.

Celco High Sensitivity Yokes minimize the deflecting currents required from the deflection drivers, resulting in high efficiency for your system.

For best utilization of the New High Resolution CRT's CELCO YOKES assure minimum defocusing at large deflections.

The construction of our yokes makes it possible to achieve **sensitivities, linearities, responses and distortion-free deflecting fields** not possible with the usual types of yoke.

Celco FOR STANDARD, COMMERCIAL & MILITARY APPLICATIONS

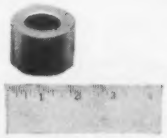
Single units or production quantities immediately available in wide range of inductance - resistance - Recovery time - pin cushion corrected or optimum focus as required. Also available 2-⅛" and 2-½" neck CRT yokes.

TYPE BY
Transistorized encapsulated yokes for 70° 7/8" neck CRT and 1" neck image storage tubes.

TYPE AY
Push-pull or single ended yokes for 52°, 70° and 90° deflections for 1-7/16" neck CRT.

TYPE RY
Rotating deflection yokes for PPI displays. Gears, bearings, slip rings and contact assembly included.

TYPE CF
Electromagnetic focusing coil for 7/8", 1" and 1-7/16" neck CRT.

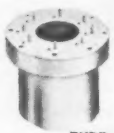


TYPE MY
Miniature light weight deflection yoke coils or assemblies for incorporation into customer housings.

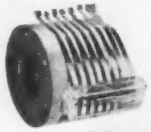
Celco ENGINEERED YOKES FOR PRECISION DISPLAYS

TYPE DP
Dual purpose yoke custom designed. Deflection system plus axial off-centering coils.

TYPE HS
Special high sensitivity deflection yoke with critical damping provisions.



TYPE PI
Plug in type encapsulated deflection yoke for rapid insertion.



TYPE ER
Encapsulated rotating, 4 axis slip ring precision deflection yoke.

TYPE MS
Miniature deflection yoke for rotating or fixed coil radar system.

Write for CELCO DEFLECTION YOKE Catalogue & Design Sheets or for assistance Call your nearest CELCO Plant listed below.

Celco

Constantine Engineering Laboratories Company

Main Plant: MAHWAH, N. J. DAvis 7-1123

• Pacific Division - Cucamonga, Calif. - YUkon 2-2688

European Setmakers Expect Rising Sales

REPORTS FROM the continent and Britain stress a bullish outlook on the part of radio-tv setmakers.

In Paris, spokesmen for the French electronics industry voiced the expectation that 1960 would wind up 12 to 15 percent ahead of 1959. Last year saw the production of 1.8 million radios and half a million tv sets.

Sales of consumer electronics in 1959 totaled $212 million, with transistor radios accounting for more than half of all radio sales. Tv set prices this year are slightly higher than last: some 17-in. sets are listed at $200, with many manufacturers posting retail prices of $250; 21-in. sets run about $325. Discounts are the exception rather than the rule

German setmaker Metz Apparatefabrik expects booming export orders to raise its sales figure. Last year, the company's sales were $11.9-million, of which roughly 30 percent was exports.

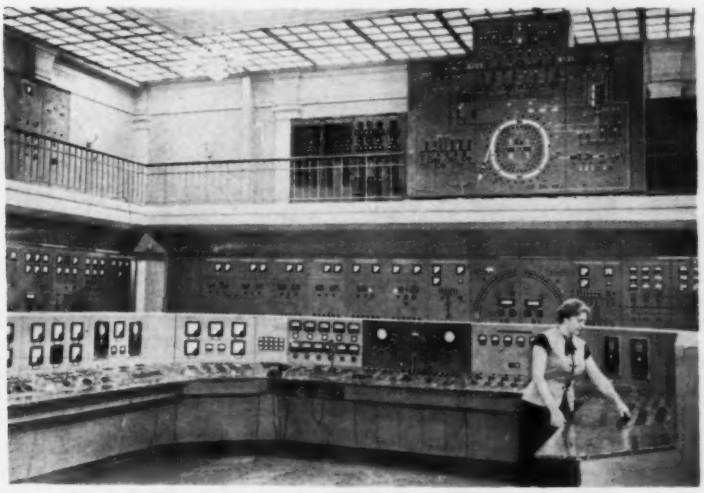
British Radio Equipment Manufacturers Association reports that radio sets are in greater demand in Britain than tv sets. July deliveries of tv sets were 40 percent below the figure for July 1959, and first-half sales are down 31 percent. Deliveries of radio sets are up about 22 percent for both July and the first half of the year. The association feels that the credit squeeze is in part responsible for the slump in tv purchases, while transistor portables are sparking radio sales.

Electronic Instruments Study Fish and Fowl

SCIENTISTS at Northwestern University in Evanston, Ill., are using electronics to determine the homing habits of birds. Each feathered subject in current experiments can choose any of eight cages arranged in a circle. An amplifier and counter for each cage determines the amount of time a bird spends in each cage. Up to the last reading, the birds seem to prefer cages with southern exposure.

Meanwhile, at Marineland of the Pacific near Los Angeles, the Navy is using highly sophisticated electronic instrumentation to study porpoises. Navy not only wants to know where the underwater mammals get their special sensing ability and how they can move so rapidly under the water, but is also trying to determine how smart they actually are.

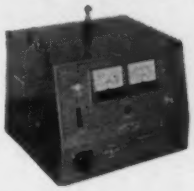
Russia's Largest Synchrotron



Soviet engineer is shown at control panel of 10-Bev synchrotron in Moscow. Total of 36,000 tons of steel went into magnets for device (Sovfoto)

TEST INSTRUMENTS for ELECTRICAL EQUIPMENT

Laboratory
Production
Maintenance



Voltage Breakdown Tests

Bench HYPOT® Test Sets, a-c and d-c models, have outputs to 30 kv. Separate 4½" meters for test voltage and leakage current. Wide selection of models.
Model 424 Bench HYPOT® provides 0-5000 v d-c. For testing cables, condensers, coils, transformers, motors, and assemblies. Measures leakage current from 0.1 microampere to 100 microamperes over four scale ranges. Rapid testing of capacitors with output of 5 milliamperes under short circuit. Operates from 110-120 v 50/60 c outlet with long-life selenium high voltage supply.
Net complete.....$497.50

- **Insulation Materials Tester**
  Dielectric strength determined to laboratory precision. Interchangeable test fixtures for varnishes, porcelain, tape, acetate sheet, films, tubing and cloth. Write for Bulletin, Model 4501 HYPOT® Materials Tester.
- **Insulating Oils Tester**
  New portable design, only 42 lbs., for testing insulating oils at point of application as well as in the laboratory. Test potential variable from 0 to 35 kv, with 2 kva rating. Write for bulletin Model 4505 HYPOT® Oil Tester.
- **Measure Resistance to FIVE MILLION MEGOHMS**
  VIBROTEST® megohmmeters provide direct reading measurements to FIVE million megohms and higher with electronic power supply that eliminates tedious cranking. Write for bulletin "VIBROTEST".
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  VIBROGROUND® measures resistance to ground of electronic, telephone, and power equipment. Direct reading. Operates from self-contained battery. Write for Bulletin "VIBROGROUND"®
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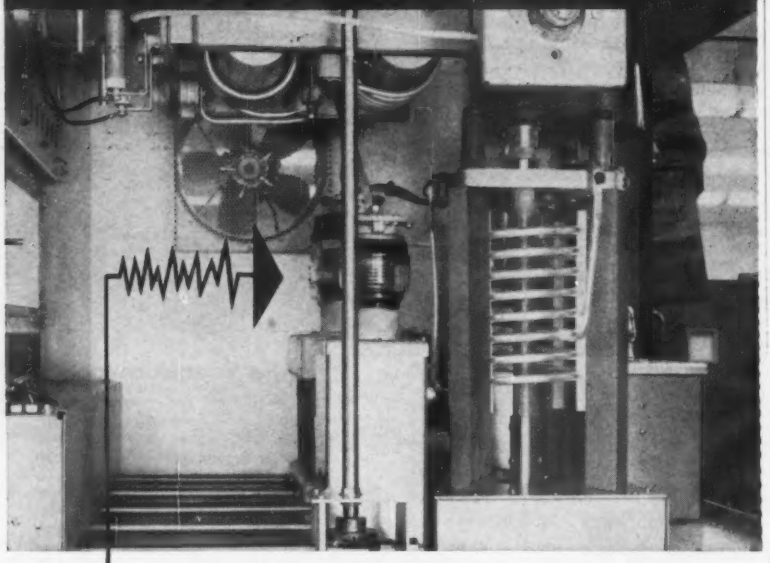
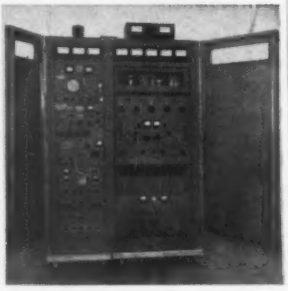
JENNINGS VACUUM CAPACITORS



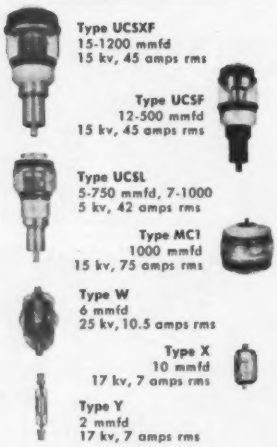
. . . speaking of capacitors—

NOTICE HOW LITTLE SPACE HIGH VOLTAGE VACUUM CAPACITORS OCCUPY!



Which is one of the reasons why Technical Materiel Corp. engineers are using 8 different types of vacuum capacitors in this new GPT-10K 10,000 watt SSB transmitter with complete band switching through its frequency range of 2 to 28 megacycles. Inductive losses are very low because the vacuum dielectric and concentric construction permits a maximum amount of capacitance at high voltage to be packed into an extremely small physical space. Vacuum capacitors also contribute to the superior performance of the transmitter through their extremely high ratio of capacitance change that makes possible a wide frequency range. Other advantages include all copper construction for high current ratings, and plates safely protected against contamination throughout their life by the vacuum seal.

Vacuum capacitors are useful in all sections of high powered transmitters, dielectric heating equipment, antenna phasing equipment and electronic equipment from cyclotrons to electron microscopes. Jennings manufactures over 300 types of vacuum capacitors with voltage ratings of 5 kv to 120 kv, and current ratings up to 500 amps rms. Further information on Jennings' complete line is available on request.



Type UCSXF
15-1200 mmfd
15 kv, 45 amps rms

Type UCSF
12-500 mmfd
15 kv, 45 amps rms

Type UCSL
5-750 mmfd, 7-1000
5 kv, 42 amps rms

Type MC1
1000 mmfd
15 kv, 75 amps rms

Type W
6 mmfd
25 kv, 10.5 amps rms

Type X
10 mmfd
17 kv, 7 amps rms

Type Y
2 mmfd
17 kv, 7 amps rms

*Reliability means Vacuum/***Vacuum** *means* Jennings®

JENNINGS RADIO MFG. CORP., 970 McLAUGHLIN AVE., SAN JOSE 8, CALIF., PHONE CYpress 2-4025

MEETINGS AHEAD

Nov. 20-21: Electro-Optical & Radiation Devices, PGED of IRE, AIEE; Stanford Research Inst., Menlo Park, Calif.

Nov. 28-29: National Association of Broadcasters, Fall Conference; Biltmore Hotel, New York City.

Nov. 29-30: Science and Engineering Symposium, Air Research and Development Command Statler-Hilton Hotel, Boston.

Nov. 30-Dec. 2: Electronics Exposition, Long Island Electronics Manufacturers Council; Roosevelt Raceway Exhibit Hall, Westbury, Long Island, N. Y.

Dec. 1-2: Vehicular Communication, Annual Meeting, PGVC of IRE; Sheraton Hotel, Phila.

Dec. 5-7: Electronic Equipment Maintenance, EIA; Hilton Hotel, San Antonio, Tex.

Dec. 5-8: Electrical Insulation, National Conf., AIEE, NEMA; Conrad Hilton Hotel, Chicago.

Dec. 8: Man's Environment in Outer Space, Institute of Environmental Sciences; Henry Hudson Hotel, New York City.

Dec. 11-15: American Nuclear Society, Winter Meeting, ANS, AIF; Mark Hopkins Hotel, San Francisco.

Dec. 12-14: USA National Committee, URSI, Fall Meeting, National Bureau of Standards; Boulder, Colo.

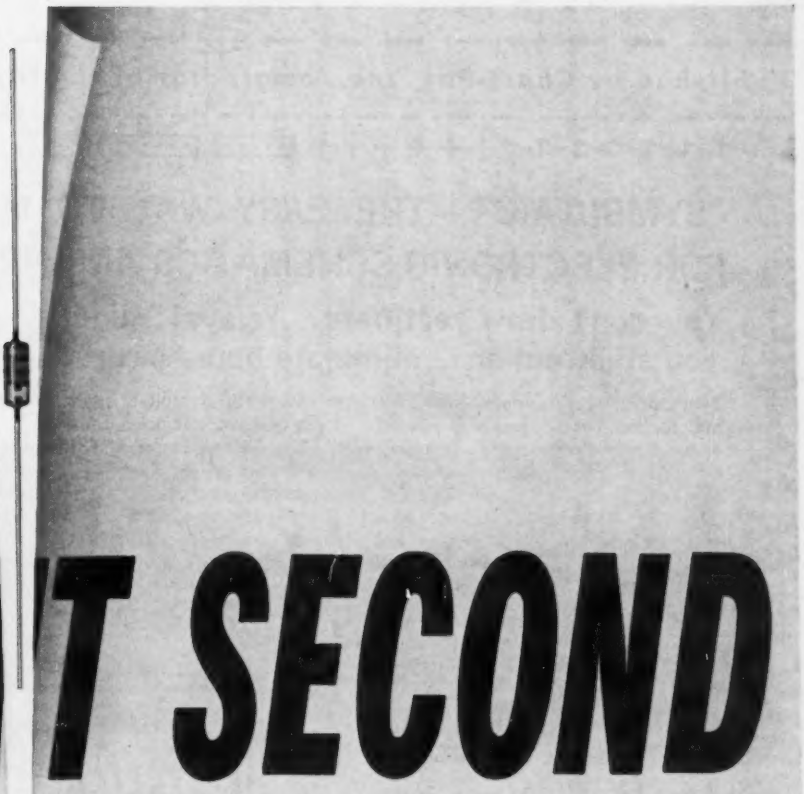
Dec. 13-15: Eastern Joint Computer Conf., PGEC of IRE, AIEE, ACM; New Yorker Hotel, New York City.

Dec. 16-17: Combined Analog Digital Computer Systems Symposium, Simulation Councils, Inc., General Electric; Sheraton Hotel, Phila.

Jan. 8-12: Thermoelectric Energy Conversion, Dept. of Defense, Joint Technical Society; Statler-Hilton Hotel, Dallas.

how to split a

SPLIT SECOND



New HUGHES® nanosecond diodes switch 50 times faster than standard germanium diodes. If your circuits require faster response, faster recovery, with greater accuracy, you can solve your problem with Hughes nanosecond diodes.

Hughes nanosecond germanium diodes are designed to make today's circuits better — and tomorrow's possible. They combine the most wanted parameters into one subminiature component. They switch 50 times faster than the usual germanium diode; they have conductances 50% higher; and they have rectification efficiencies greater than 70%. They have higher Q and faster recovery (both forward and reverse), which give your circuits greater accuracy and extremely low transient losses.

These new semiconductors were created especially for high-speed computer logic, high-frequency transistor circuits, extremely fast reference switching, and low-noise, low-level RF modulation and demodulation. If you're working with sophisticated circuitry with exacting requirements, the Hughes Semiconductor sales engineer in your area is a good man to know. Call him.

Or write Hughes Semiconductor Division, Marketing Department, 500 Superior Avenue, Newport Beach, California.

SPECIFICATIONS

Types	Minimum Forward Voltage @ 100 MA (V)	Minimum PIV @ I_R = 100μA (V)	Max. Rev. Current @ Specified Voltage (μA)	(V)	Min. Rectification Efficiency JAN (%)	Maximum Capacitance At 0 Bias @ 100Kc (pf)	Maximum Dynamic Impedance @ 1mAdc & 0.1mA RMS (ohms)	MAX. REVERSE RECOVERY T_{RR} to R (nsec)	(KΩ)	Recov. Circ. Switching (R_L = 100Ω) I_F (mA)/V_R
HD2963	.65	7	10	5	65	4	40	6	2	10/-6
HD2964	1.00	20	10	5	60	2	60	3	2	10/-6
HD2967	.75	4	40	2.5	65	4	40	6	1	3/-3
HD2968	1.00	6	40	2.5	60	3	80	4	1	10/-6

Note: The recovery characteristic was measured on the lumatron sampling scope.

Creating a new world with ELECTRONICS

HUGHES

SEMICONDUCTOR DIVISION

HUGHES AIRCRAFT COMPANY

DRAWING BOARD NEWS.....No. 1

Published by Chart-Pak, Inc., originator of the tape method of drafting

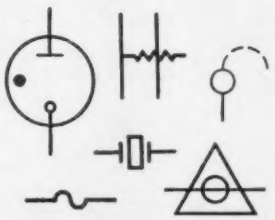
"SYMBLTAK"®—THE EASY WAY TO MAKE DRAWINGS FOR ELECTRONIC SCHEMATICS AND PRINTED CIRCUITS

You don't draw rectifiers...relays...diodes...conductor paths... you stick 'em on...eliminate hours of drudgery

Symbltak is a revolutionary new drafting method using precision-printed, pressure-sensitive materials. It greatly simplifies the production of electronic schematics and printed circuits.

With Symbltak, you no longer have to draw and ink-in circuit symbols and conductor paths. You use pre-printed, precision-cut Symbltak symbols and tapes that you just press down!

Chart-Pak tapes and Symbltak symbols are accurately scaled; can be positioned with great precision on Precision Grids. They are easily altered by scraping or dissolving surface printing and re-inking; easily repositioned.



HUNDREDS OF "PRESS-DOWN" SYMBOLS SAVE HOURS OF SLOW PEN-WORK

All are standardized to meet Gov't., Military specifications

328 Symbltak symbols are drawn in accordance with the American Standards Association, ASA Y 32.2 sponsored by the AIEE and ASME; also with MIL-STD-15A for government procurement of electronic drawings. When you press down a Symbltak "Amplifier—Ext. Feedback Path" . . . "Transistor Pentode (LH)" or printed conductor-path "elbow" . . . you know it's right! And it will reproduce beautifully.

NEW DRAFTING FILM WON'T STRETCH, SHRINK, PUCKER

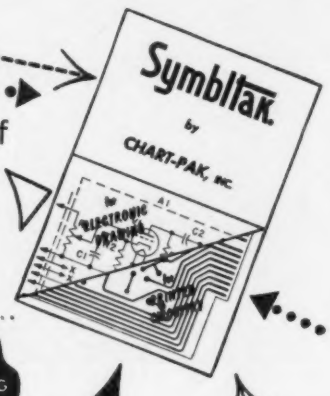
Both expert draftsmen and blueprinters say Chart-Pak's new FUTURA Drafting Film is the most satisfactory medium available. It is made of DuPont Cronar®, for exceptional resistance to heat, cracking, tearing or soiling. It is finished with a mechanically-produced matte surface, on one or both sides — that takes pen and pencil beautifully — reduces smudging or feathering — erases easily. FUTURA has exceptional clarity and dimensional stability. Samples on request.

CHART-PAK develops new glare-proof tapes

Now, for the first time — you can get matte-surface acetate-fibre tapes that won't "talk back" to a camera with highlights or glare. These ingenious Chart-Pak tapes provide a non-reflective surface, without excess thickness.

You have a thin, one-piece tape that won't reflect, cast shadows, separate, shrink, yellow or peel — in many colors and widths. Use Chart-Pak *matte-surface* tapes, wherever glare is a problem.

New folder to help you take the drudgery out of printed circuitry



For complete information on the new Chart-Pak system that makes layout easier, write for free folder — "Symbltak."

WRITE WITH AN ORDINARY PEN OR PENCIL TO...

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14 great new copy machines in the Ozalid®-Ozafax line!

Each one styled, sized, and priced to give you maximum efficiency for every office or plant need.

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In seconds, these machines make office and engineering reproductions you can hardly tell from originals. Save you time, work, money. Eliminate office copying errors, retyping, proofreading, double-checking. Increase print output, reduce reproduction costs. Paper cost? As little as 1¢ for a letter-sized copy.

Find out about the complete Ozalid-Ozafax line. Talk to an Ozalid salesman or write: Ozalid, Johnson City, N. Y. In Canada, Hughes-Owens Ltd., Montreal.

Ozalid for '61—boldest new look in the business!

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Every touch of a Switch is a test of your equipment!

The design of switches for complex electronic equipment is a specialty, one place where you can save valuable engineering design time and insure reliable input. But, don't stake your reputation on less than the finest. MICRO SWITCH precision and reliability will safeguard your performance standards.

75 YEARS HONEYWELL PIONEERING THE FUTURE

Consult the Yellow Pages for the location of the nearby MICRO SWITCH branch office. Engineering assistance is available without obligation.

New MICRO SWITCH Synchronized One-Shot switch circuit assemblies save engineering time and equipment rack space

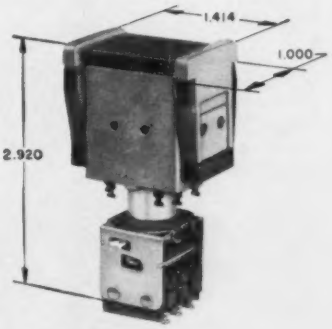
New Synchronized One-Shot push-button switch circuit assemblies for use in pulse and digital systems save design time required to develop flip-flop and gating networks.

The new MICRO SWITCH "1PB700" series assemblies have a special electronic circuit that generates a single square wave output pulse in synchronism with an external clock pulse with each operation of the push button. They can be used with clock pulse frequencies from 4 kc to 500 kc.

The electronic circuit is an integral part of the push-button switch, resulting in a saving of equipment rack space. All circuit components are sealed in resilient potting material to insure protection from physical damage.

Three assemblies in the new series are patterned to fit a wide variety of d-c supply voltages and clock pulse rise times, voltages and frequencies. They can be applied to manual loading of magnetic drums, setting and resetting flip-flops, and checking ring counters. Ask for Data Sheet 172.

MICRO SWITCH modular lighted push-button switches can be customized for complete design flexibility

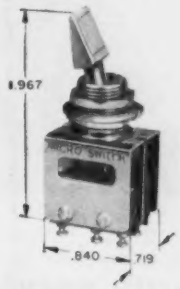


Give your control panel the finest in styling with the customizing that will precisely fit your control and display functions.

MICRO SWITCH "Series 2" lighted push-button switch modules simply snap together to match your styling requirements, then snap into slots in the mounting panel—all without tools. They perform both control and indicator jobs to save panel space.

Select from 48 different units and 16 mounting barriers. Forty color display screens include lateral and longitudinal divisions. Available as operator-indicator switch units or indicator units only. Ask for Catalog 67.

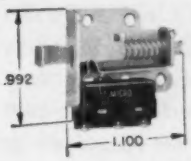
MICRO SWITCH precision toggle switches offer you the exact control arrangements you need



MICRO SWITCH manufactures hundreds of different toggle switches and toggle switch assemblies. They are available with 2 or 3 operating positions, 1 or 3-hole mounting and a variety of circuitry and electrical ratings. All have enclosed type contacts. Ask for Catalog 73.

A new "400" Series Toggle Switch is now available with a paddle-shaped tab which can be numbered or color-coded as an indicator.

MICRO SWITCH door interlock switches assure maximum safety during maintenance



MICRO SWITCH door interlock switches are installed on high voltage cabinets to automatically cut the power circuit when the cabinet door is opened for repairs or testing.

Safety position adds protection against "tying down" or wiring around a conventional switch which might be forgotten after service is completed. By manually pulling the plunger out to the maintained-contact position, you close circuit for checking. When door is closed, plunger automatically returns to normal operating position. Ask for Catalog 63.

MICRO SWITCH . . . FREEPORT, ILLINOIS
A division of Honeywell
In Canada: Honeywell Controls Limited, Toronto 17, Ontario

Honeywell
MICRO SWITCH Precision Switches

Men and machines of AIR EXPRESS deliver vital missile component with jet speed to Convair test site

Priority service makes Air Express today's best way to ship

At Convair's big Sycamore Canyon Test Facility in California, an Atlas missile stands ready for a static test firing. An eleventh-hour engineering refinement brings AIR EXPRESS service into the picture. AIR EXPRESS is constantly called on to speed new parts. It's all in the day's (or night's) work for this skilled shipping team. Here's what you get when you call AIR EXPRESS: Priority service—first on, first off —on all 35 scheduled U. S. airlines • Kid-glove handling every mile of the way • Door-to-door pickup and delivery via 13,000 trucks (many radio-dispatched for maximum speed) • Teletype confirmation of receipt on request • Service to 20,000 American communities coast to coast • It pays to think fast . . . think AIR EXPRESS first!

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Extra quality at no extra cost with Bendix Semiconductors

Bendix Bulletin

NEW 25-AMP DAP TRANSISTORS SWITCH IN MICROSECONDS

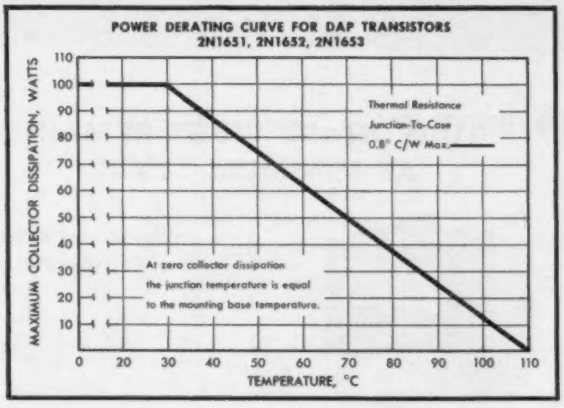
High Current–Fast Switching–High Voltage —give engineers wider design latitude

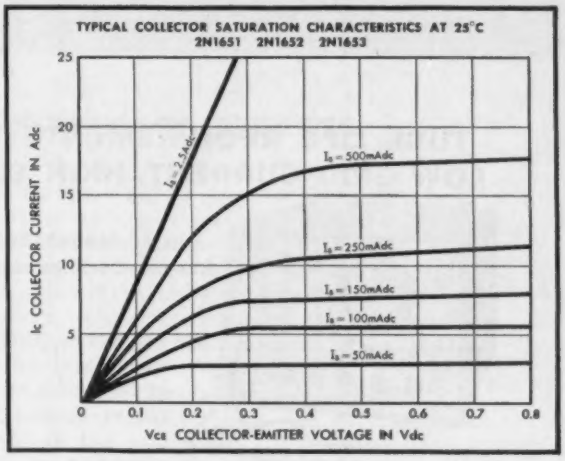
The new 25-amp germanium PNP Bendix® Diffused Alloy Power DAP® transistor line—with its microsecond-fast, higher-current switching (typically 5 μsec at 25 amperes)—frees engineers from the design restrictions set up by ordinary germanium alloy transistors. *Only* Bendix offers such a high-current, high-speed DAP transistor line.

But high current is by no means the whole story. Bendix DAP transistors make possible increased circuit stability over a wider range of temperatures—from −60°C to +110°C. They are also rated at higher collector-to-emitter breakdown voltages, while providing lower input resistance, controlled current gain, and lower saturation voltages. In short, here is a special high-frequency, high-voltage line that opens the door to many new design ideas and applications.

For details on our complete line of power transistors, power rectifiers, and driver and MIL-type transistors, write on your letterhead for your BENDIX SEMICONDUCTOR CATALOG.

ATTENTION ENGINEERS: Write our Employment Manager for information about challenging opportunities we offer in semiconductors.





ABSOLUTE MAXIMUM RATINGS

TYPE NUMBERS	V_{CB} Vdc	V_{CE} Vdc	V_{EB} Vdc	I_C Adc	P_C W	T Storage °C	T_J °C
2N1651	−60	−60	2.0	25	100	−60 to +110	110
2N1652	−100	−100	2.0	25	100		
2N1653	−120	−120	2.0	25	100		

Ideal for such applications as: ULTRASONICS • HORIZONTAL OUTPUT AMPLIFIERS FOR TV OR CATHODE RAY TUBES • POWER CONVERTERS • HIGH CURRENT AC SWITCHING • CORE DRIVERS • HI-FI

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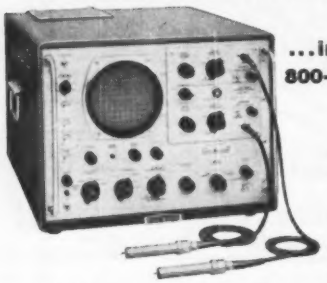
CIRCLE 61 ON READER SERVICE CARD

CIRCLE 62 ON READER SERVICE CARD→

In RELIABILITY, test the equipment tested. G-E Five-Star Tubes application needs best

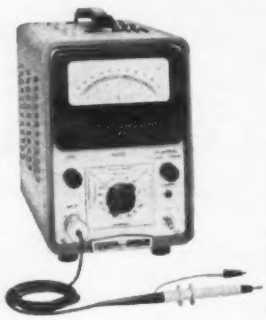
TUBE LIFE REQUIREMENTS: LOW GRID CURRENT, HIGH G_m



...in hp Model 185A 800-mc Oscilloscope

Advanced pulse-sampling circuitry of the 185A calls for an amplifier tube with (1) grid current so low that current is not withdrawn from a grid-to-ground storage capacitor, and (2) high G_m for maximum amplification. These characteristics must be maintained. General Electric's 5-Star 5654 was chosen by Hewlett-Packard after extensive tests; helps in producing a dependable high-speed instrument to measure transistor response time and diode switching speeds, and test fast computer circuits and surveillance radars.

TUBE NOISE MUST REMAIN AT MINIMUM LEVEL



...in hp Model 425A Micro Volt-Ammeter

So sensitive it will measure down to 10 microvolts and 10 micro-microamperes—stable, with extremely low drift – Hewlett-Packard's 425A calls for sustained tube performance at minimum noise level. In the key amplifier socket for modulator output, General Electric 5-Star 5751-WA's have cut line rejects from noise sharply, and help preserve usefulness of the equipment after it is placed in service. Before, another tube in the same socket caused a 30% reject rate!

instruments must surpass Hewlett-Packard (hp) uses because they satisfy ....here is your proof!

TUBES MUST STAY FREE OF INTERFACE EFFECTS

...in (hp) Model 460B
Wide Band Amplifier

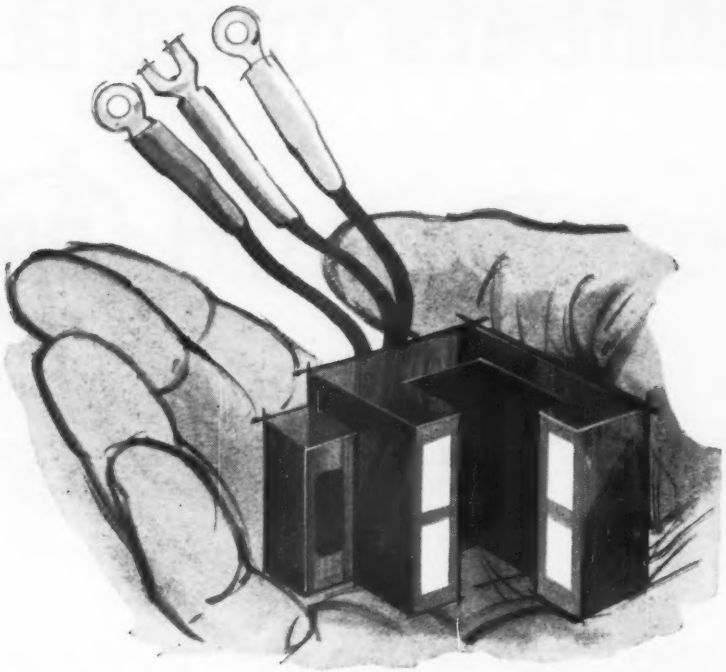
In order that high pulse power or voltage may be applied to a load, Hewlett-Packard's 460B uses 13 5-Star 5654 tubes in a distributed-amplifier circuit. Tube requirements are severe. The high-voltage, low-duty cycle pulses entail operation at max ratings for brief intervals, between long periods of tube cut-off. Interface effects would handicap reliability. General Electric's 5654's score both in minimum interface and high over-all performance...help Model 460B meet consistently, often exceed, its operating specifications.

TELEPHONE TODAY! New York, WI 7-4065...Boston, DE 2-7122...Washington, EX 3-3600
Chicago, SP 7-1600...Dallas, RI 7-4296...Los Angeles, GR 9-7765, BR 2-8566...San Francisco, DI 2-7201

Progress Is Our Most Important Product

GENERAL (GE) ELECTRIC

431-101



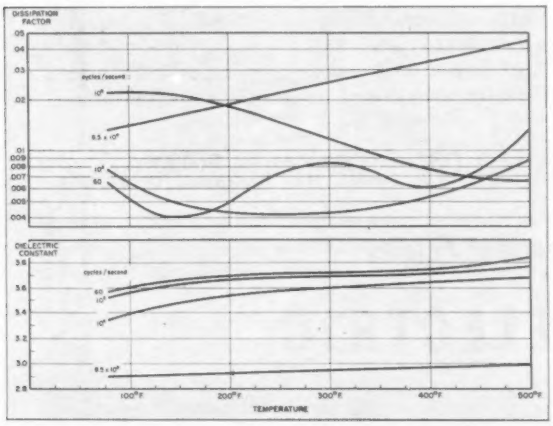
How your epoxy resin potting systems can beat the heat... even above 500° F.

Turn an appraising eye on the chart below, and you will see why it is now possible to get good electrical properties in your epoxy potting compounds even at temperatures of 500° F. and higher.

These data were obtained in tests of epoxy systems which had been cured with Du Pont's pyromellitic dianhydride (PMDA).

Note the unusual stability of electrical properties at elevated temperatures. Equally outstanding thermal resistance is a bonus characteristic of PMDA cured systems.

PMDA is now available in commercial quantities, to help you add these exceptional electrical and thermal characteristics to *your* epoxy resin potting, encapsulating, and laminating systems.



There's more. PMDA provides several advantages in addition to outstanding electrical and thermal properties.

If you wish, you can get long pot life—up to 2 days at room temperature or 6 hours at 165°F. On the other hand, if you want a quick cure—say, 15 minutes at 355° F.—you can get it by simply changing the formulation and at no sacrifice in electricals.

Why not take advantage now of such outstanding performance and use PMDA to achieve improvements in your product. PMDA is now available in quantity from Du Pont's new commercial-size plant. Recent price reduction to $1 per pound* also makes this a practical means of improving your epoxy resin systems.

For more details or for samples of PMDA, write to Du Pont, Explosives Department, 6539-K Nemours Building, Wilmington 98, Delaware.

**Price quoted is f.o.b. Gibbstown, New Jersey for material in standard containers and is subject to change without notice.*

DU PONT PMDA

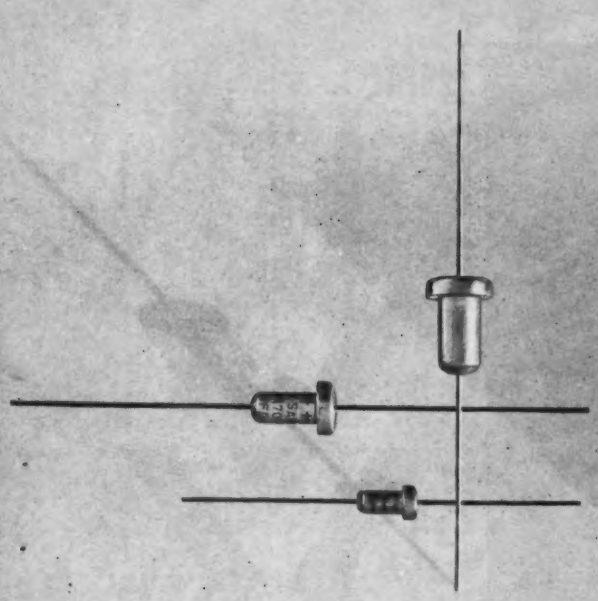
REG. U. S. PAT. OFF.

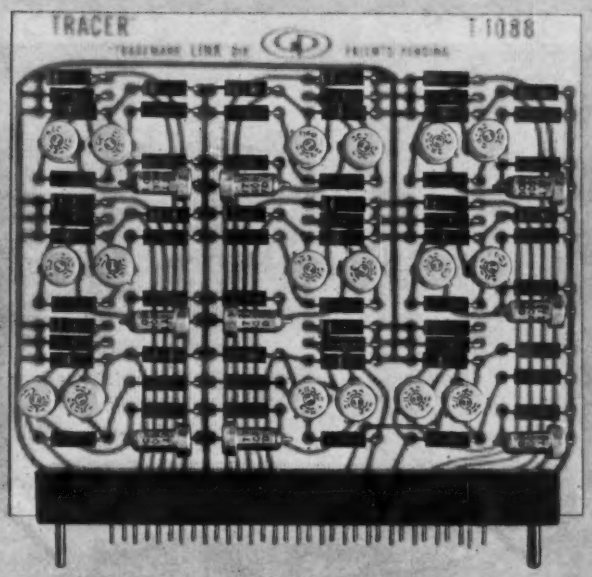
(PYROMELLITIC DIANHYDRIDE)

BETTER THINGS FOR BETTER LIVING

... THROUGH CHEMISTRY

←CIRCLE 63 ON READER SERVICE CARD CIRCLE 64 ON READER SERVICE CARD CIRCLE 65 ON READER SERVICE CARD →





Link Division of General Precision, Inc. specified ITT capacitors for this vital portion of its Tracer Identification and Control System, which demands utmost reliability and long life expectancy from every component.

TOTAL PROCESS CONTROL AND DISCIPLINED PRODUCTION DELIVER

HIGH-RELIABILITY WET-ANODE TANTALUM CAPACITORS FROM ITT

ITT wet-anode tantalum capacitors meet MIL-C-3965B—a fact proved by independent laboratory qualifications tests on ITT capacitors. The reliability and long life expectancy of these competitively-priced capacitors are direct results of ITT's total process control and disciplined production procedures, above and beyond testing standards more stringent than normal industry practice—and backed by ITT's world-wide facilities and experience.

ITT
COMPONENTS DIVISION
INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION
815 SAN ANTONIO RD., PALO ALTO, CALIF.

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Dallas	EM 1-1765	Philadelphia	TR 8-3737
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Denver	KE 4-5091	Rochester	FI 2-1413
Detroit	TO 8-3322	San Francisco	LY 1-7321
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Kansas City	JE 1-5236	St. Louis	EV 2-3500

IN STOCK AT ITT DISTRIBUTORS:

- TWO TYPES—M-Type and P-Type, for applications from −55 to 85 and 125 C. respectively
- 29 VALUES—from 1.75 to 330 mfds over a working voltage range to 125 VDC and maximum surge voltages to 140 VDC
- COMPACT AND RUGGED—sintered tantalum slug in fine-silver cases for 2000-hour life at maximum temperature and working voltage
- GUARANTEED—to 80,000 ft. and accelerations of 20 G's with a 0.1 in. excursion in 50-2000 cps range
- LONG STORAGE LIFE—tantalum-oxide dielectric is completely stable; assures trouble-free operation

COMPLETE SPECIFICATIONS ON ITT wet- and solid-anode tantalum capacitors are available on request. Write on your letterhead, please, to the address below.

ENGINEERS: Your ITT representative has a complete set of qualifications and quality control tests for your inspection.

P. I. tape recorder secret is an open book

A unique stacked-reel tape magazine is one of many space-saving secrets which enable Precision instrumentation recorders to out-perform conventional magnetic tape instruments many times their size. Other design secrets are push-button selection of function and speed, light beam end-of-tape sensing, front panel calibration and testing, interchangeable tape loop magazines, and all-solid-state plug-in electronics.

All the secrets of these recorders are unveiled in detailed new brochure 55B. Write for your copy today.

14-CHANNEL
PRECISION RECORDER
Loaded magazines can be interchanged in 5 seconds.

P. S. – Here's an installation secret – two complete 14-channel analog (or 16-channel digital) recorders mount in only 51" of vertical rack space.

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1011 Commercial Street • San Carlos • California
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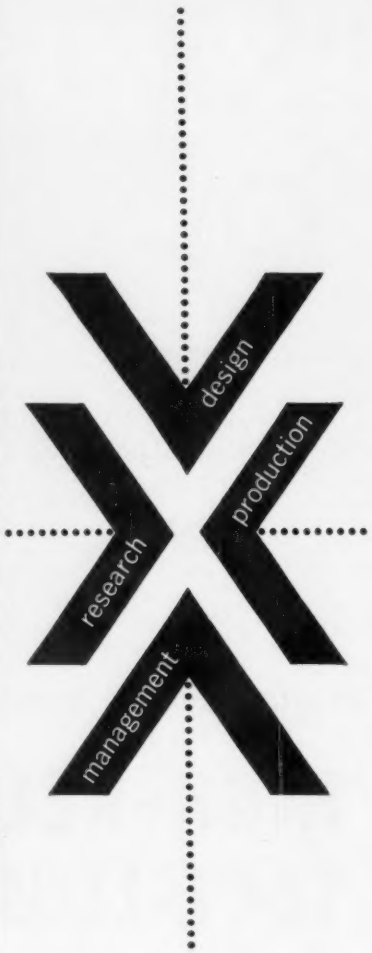
REPRESENTATIVES IN PRINCIPAL CITIES THROUGHOUT THE WORLD



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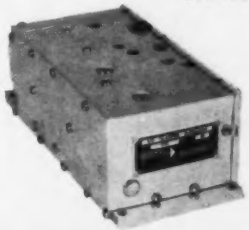
COMPLETE LINE OF VHF TELEMETRY EQUIPMENT

MANY ITEMS AVAILABLE FROM STOCK

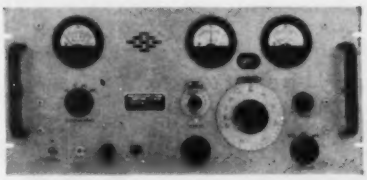


TELEMETRY TRANSMITTER, 215 – 265 mc

Improved frequency stability, true frequency modulation, reduced harmonic distortions, and increased power output characterize GEL's VHF Telemetry Transmitter, Type 15A2, specifically designed to meet the exacting requirements of present day telemetry systems.

FEATURES

- *Shock:* 100g, 11 milliseconds
- *Vibration:* 15g, 2000 cps
- *Frequency Stability:* ±0.005%
- *Distortion:* Less than 1%
- *Modulation:* FM/FM, PDM/FM, PCM/FM
- *Temperature Range:* −54°C to +85°C

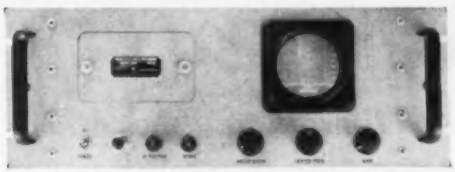


TELEMETRY RECEIVER, 215 – 265 mc

Designed in comformity with IRIG requirements specifically for use in FM/FM, PDM/FM, and PCM/FM Systems, GEL's Telemetry Receiver, Type 11B1, provides a versatility heretofore unobtainable. Other bandwidths than those shown below, or special response characteristics are available on order.

FEATURES

- *IF Bandwidths:* Plug-in type, 100, 300, 500, 750kc
- *OSC Radiation:* Meets MIL — I — 6181
- *VFO or Crystal:* Operation selected by panel switch
- *Image Rejection:* Greater than 60 db
- *Noise Figure:* Less than 7 db

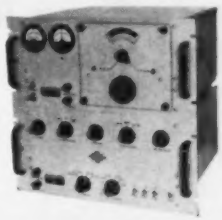


FREQUENCY DISPLAY UNIT, SERIES 14

Accepting signals from GEL Receivers, Frequency Display Unit, Series 14, features good resolution, equalization ±3 db, low spurious radiation, edge-lighted scale, and 60 db image rejection. A signal as low as 2 microvolts at the Receiver input gives full-scale deflection.
Sweep width, center frequency, and gain control are located below a 3" Cathode Ray Tube. Unit mounts in 19" Relay Rack. Series 14 Frequency Display Units are companion units to GEL VHF Receivers.

FEATURES

- Low Spurious Radiation
- Edge-lighted Scale
- Pentagrid Mixer
- Switch for Multiple Inputs
- 20k resolution
- Adjustable sweep width 0 to 3 mc



WIDE RANGE RECEIVER, 30 – 260 mc

GEL Wide Range Receiver, Type 17A1, is used in a broad variety of applications, and is designed to receive AM, FM, and Pulse information. This unit is characterized by extreme sensitivity to the reception of weak signals. The tuning head is contained in a completely shielded sub-assembly, and has very low oscillator radiation. Tuning range is covered in two bands selectable from the front panel. Panels are notched for 19" Relay Rack mounting. Power consumption is 225w at 115-230v a-c 50-60 cycles.

FEATURES

- *Input Impedance:* 50 ohm source with separate antenna input for each band
- *Frequency:* Band 1: 30-60 mc; Band 2: 55-260 mc
- *Noise Figures:* Band 1: Less than 5 db; Band 2: Less than 6 db
- *Oscillator Radiation:* 90 db below 1 mw at antenna terminal
- *IF Bandwidths:* 10 kc, 300 kc, 4 mc

GEL Also Designs and Manufactures a Complete Line of Telemetry Equipment for Microwave Applications

Write for Technical Data Sheets on Compatible GEL Telemetry Equipment in the VHF Band.

ADDRESS ALL INQUIRIES TO:
General Electronic Labs, Inc.
8521 Second Avenue
Silver Spring, Maryland

GENERAL ELECTRONIC LABORATORIES, INC.
CAMBRIDGE 42, MASS SILVER SPRING, MD.

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are creating a climate conducive to significant scientific achievement

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Among those providing their leadership to this new non-profit public service corporation are: Dr. Ivan A. Getting, president; Allen F. Donovan, senior vice president, technical; Jack H. Irving, vice president and general manager, systems research and planning; Edward J. Barlow, vice president and general manager, engineering division; and Dr. Chalmers W. Sherwin, vice president and general manager, laboratories division.

These scientist/administrators are now selecting the scientists and engineers who will achieve the mission of Aerospace Corporation: concentrating the full resources of modern science and technology on rapidly achieving those advances in missile/space systems indispensable to the national security.

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A new and vital force engaged in accelerating the advancement of space science and technology

SERIES F TARZIAN Silicon Rectifiers

Tarzian Type	Amps. DC (85° C)	PIV	Max. RMS Volts	Max. Amps. Recurrent Peak	Max. Amps. Surge (4MS)	Jedec Equiv.
2F4	.20	400	260	2.0	20	— —
F-2	.75	200	140	7.5	75	1N2482 / 1N2069
F-4	.75	400	280	7.5	75	1N2483 / 1N2070
F-6	.75	600	420	7.5	75	1N2484 / 1N2071

0.2″ maximum diameter
0.4″ maximum length

How many?

100? 1,000? 10,000? 100,000? 1,000,000?

If Series F units meet your design requirements, then you can specify with full assurance of availability in any quantity.

These Series F units are widely useful. They combine small size, low cost, high performance and Tarzian reliability. They are interchangeable with many other rectifiers. Junctions are oversize—handle inrush currents far beyond normal circuit requirements. Temperature rise is low and reliability is increased.

The insulated body of the Series F units presents no mounting problems. And low cost with high quality results from Tarzian production methods.

For additional information about Series F rectifiers, call your Sarkes Tarzian sales representative, or write Section 5760. Sarkes Tarzian is a leading supplier of silicon, tube replacement, and selenium rectifiers. Practical application assistance is always available.

SARKES TARZIAN, INC.

World's Leading Manufacturers of TV and FM Tuners • Closed Circuit TV Systems • Broadcast Equipment • Air Trimmers • FM Radios • Magnetic Recording Tape • Semiconductor Devices

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Can a silicon rectifier solve your problem?

It might, if you have a problem in DC power sources. For example, some time ago C & D needed a high efficiency, constant potential, current limiting DC power supply. Output had to be held within ± 1% over an AC input variation of ± 15%. In addition, maintenance would have to be virtually nil.

The answer was found by using a silicon rectifier in combination with simplified components that became the heart of C & D's *AutoReg*® charger. *AutoReg* chargers provide continuous, automatic, unattended charging of industrial storage batteries. With the exception of a timing circuit there are no moving parts. There are no relays to adjust and practically no maintenance is required.

Now, C & D has expanded facilities of the *AutoReg* plant to provide industry with similar DC sources, which incorporate silicon rectifiers and automatic regulation. Final form of these units can supply power in a range from milliwatts to megawatts, depending upon your requirements.

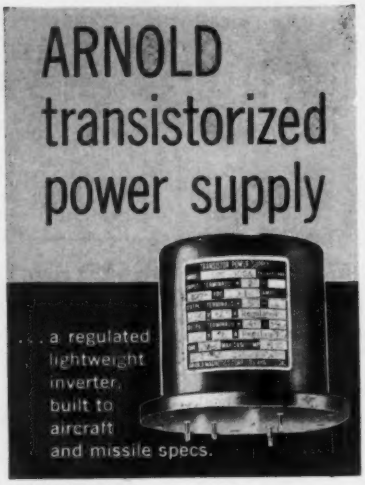
Companies with a problem in DC power sources should write, giving a general outline of their requirements, to: *Vice President in Charge of Engineering*

AutoReg® Power Sources

C&D C & D BATTERIES
of Conshohocken, Pa.... Attica, Ind.
DIV. THE ELECTRIC AUTOLITE CO.

Manufacturers of Styver-Clad® Industrial Batteries • PlastiCell® and PlastiCal® Batteries for Communications, Control, and Auxiliary Power • Producers of AutoReg® Silicon Chargers and AutoCal® Charger-Battery Combinations

ARNOLD transistorized power supply



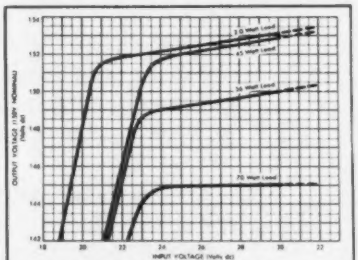
FEATURES

- Constant output voltage as battery discharges
- 1/5 weight, 1/2 size of comparable dynamotors.
- Withstands short circuit indefinitely.
- Withstands input voltage transients of 70 volts for 0.1 sec. and 60 volts, indefinitely.
- Output voltage drift only 1.5% from −55° to +71°C.

SPECIFICATIONS

D. C. OUTPUT Model 591-A
Input Voltage: 24-30 VDC
Output Voltage: Any from 25-1200 VDC
Output Power: 60 watts regulated
Regulation: Line: ±0.5% for 6V variations
Load: ±1.0% for ½ L to FL
Ripple: 0.3% RMS
Size & Weight: 3" OD x 3 1/16" high; 22 oz.

A. C. OUTPUT Model 591-AC
Input Voltage: 24-30 VDC
Output Voltage: 115 VAC, 400 cps, 1 phase
Output Power: 50 V.A. square wave
Regulation: Frequency: ±0.5%
(line & load) Voltage: ±2.0%
Size & Weight: 3" OD x 3 1/16" high; 22 oz.



OUTPUT VOLTAGE VS. INPUT VOLTAGE at several fixed loads. (MOD. 591—typical values)

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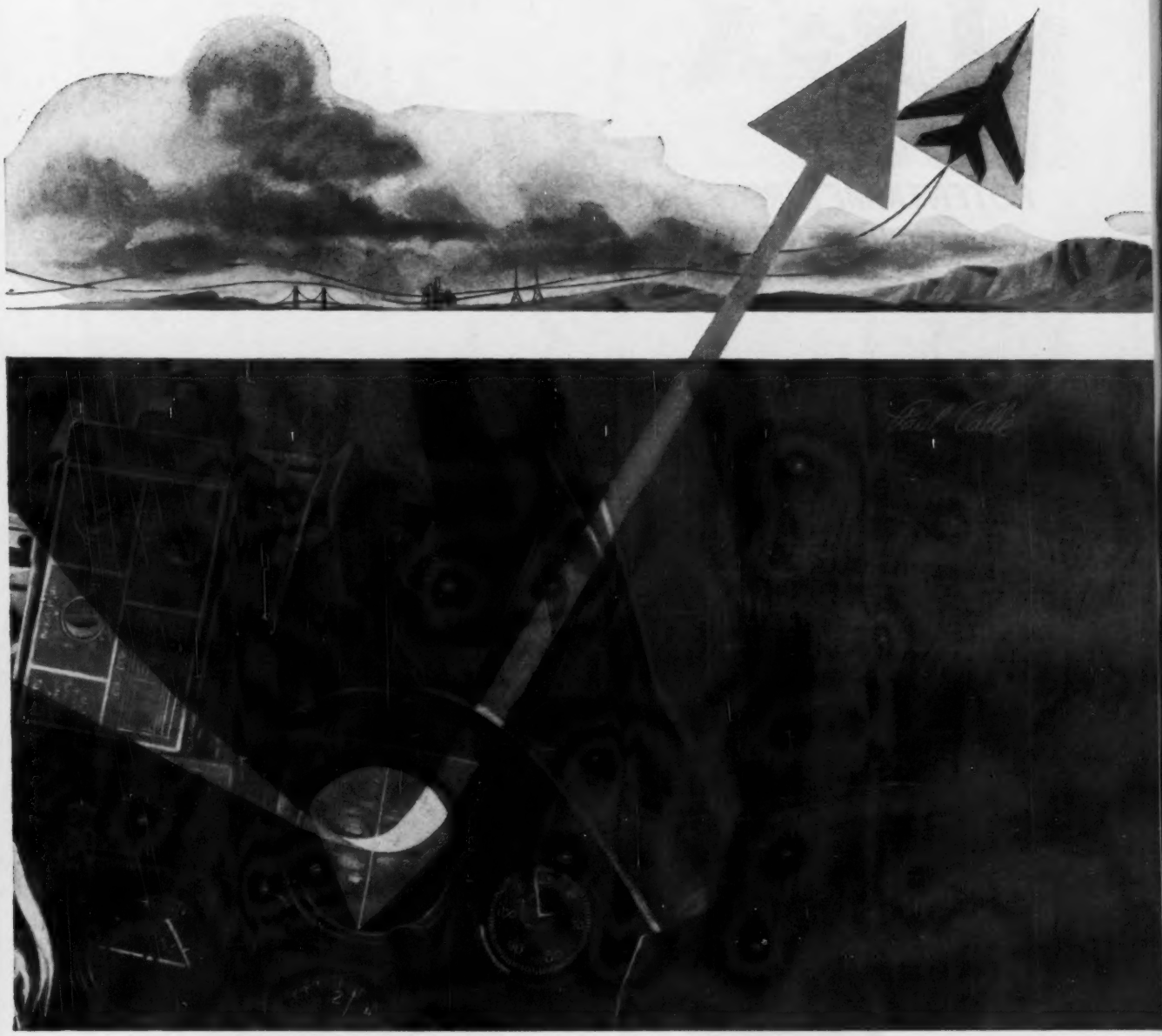

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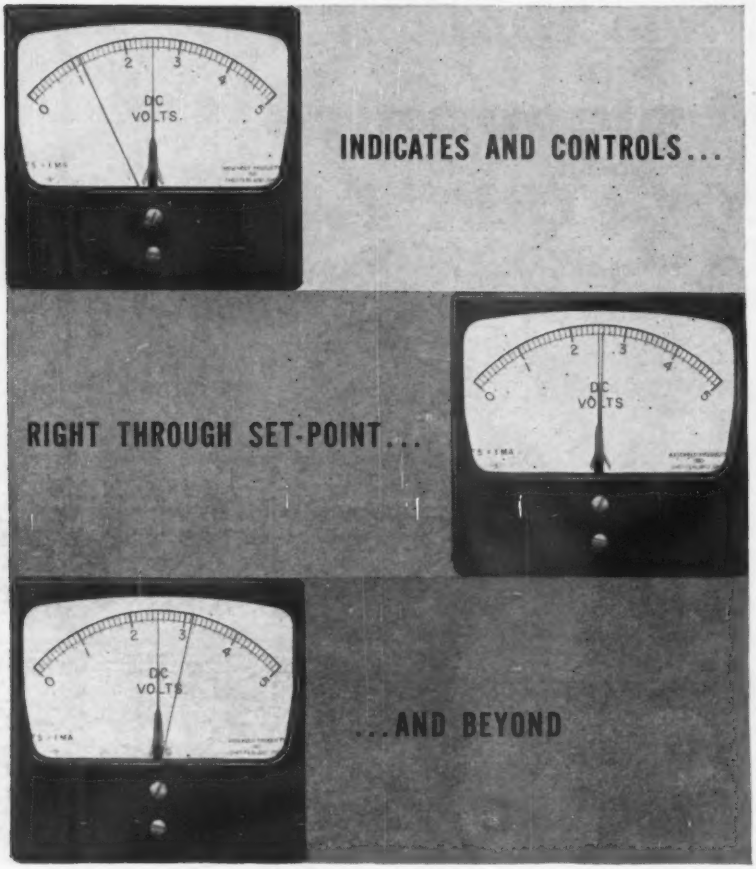

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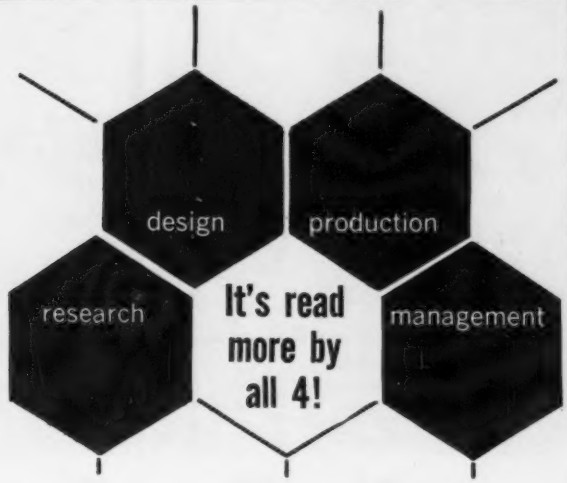

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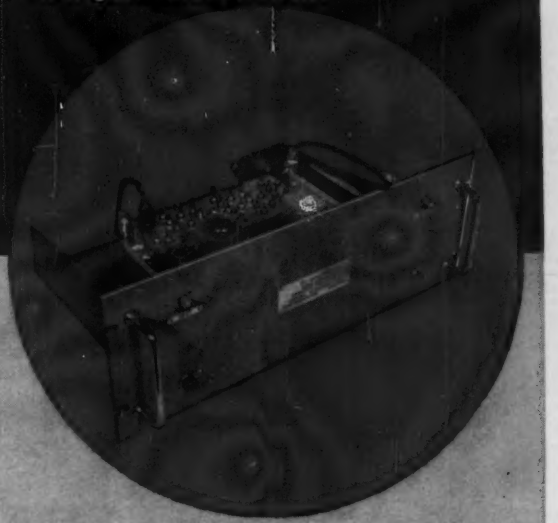

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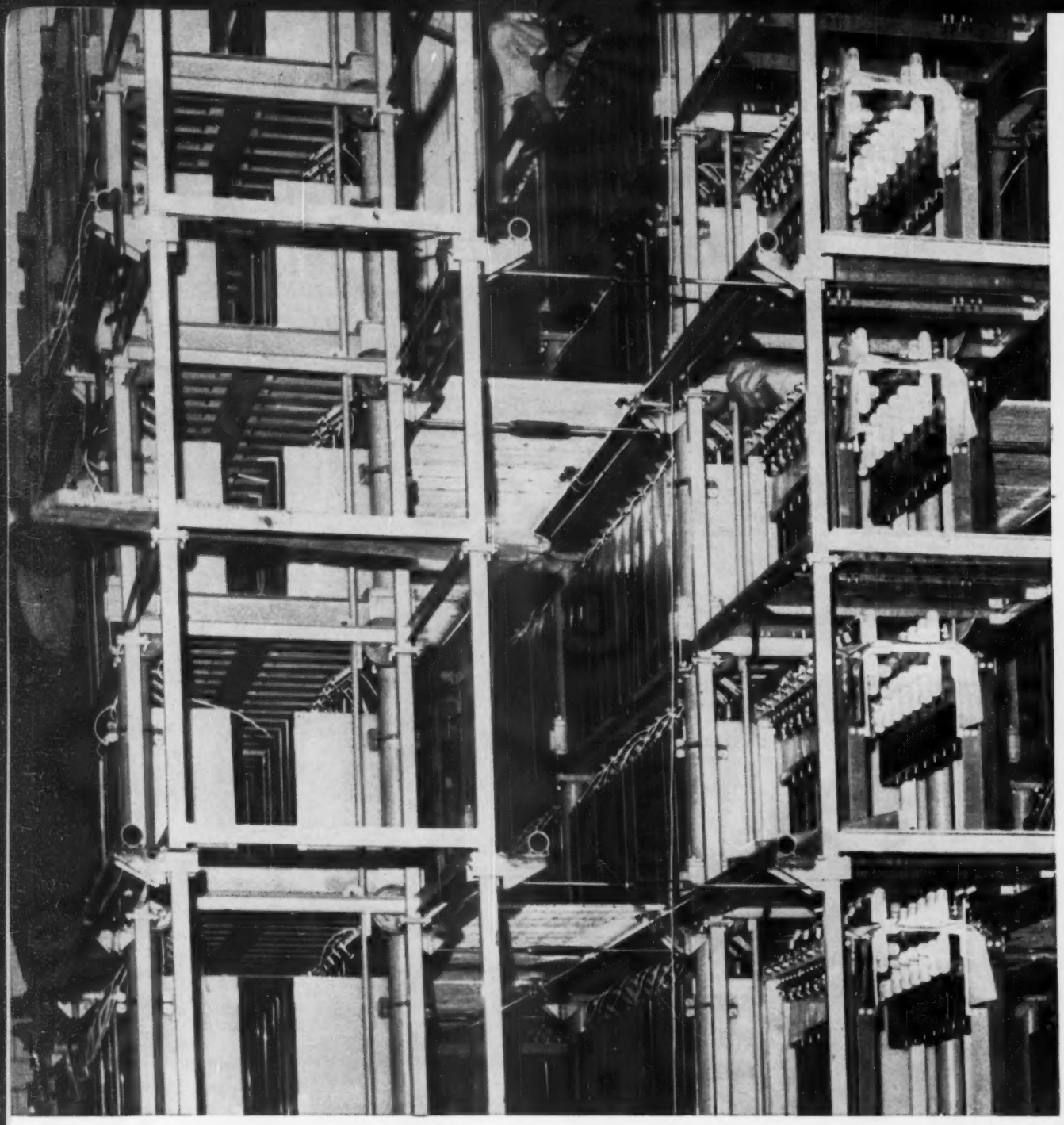

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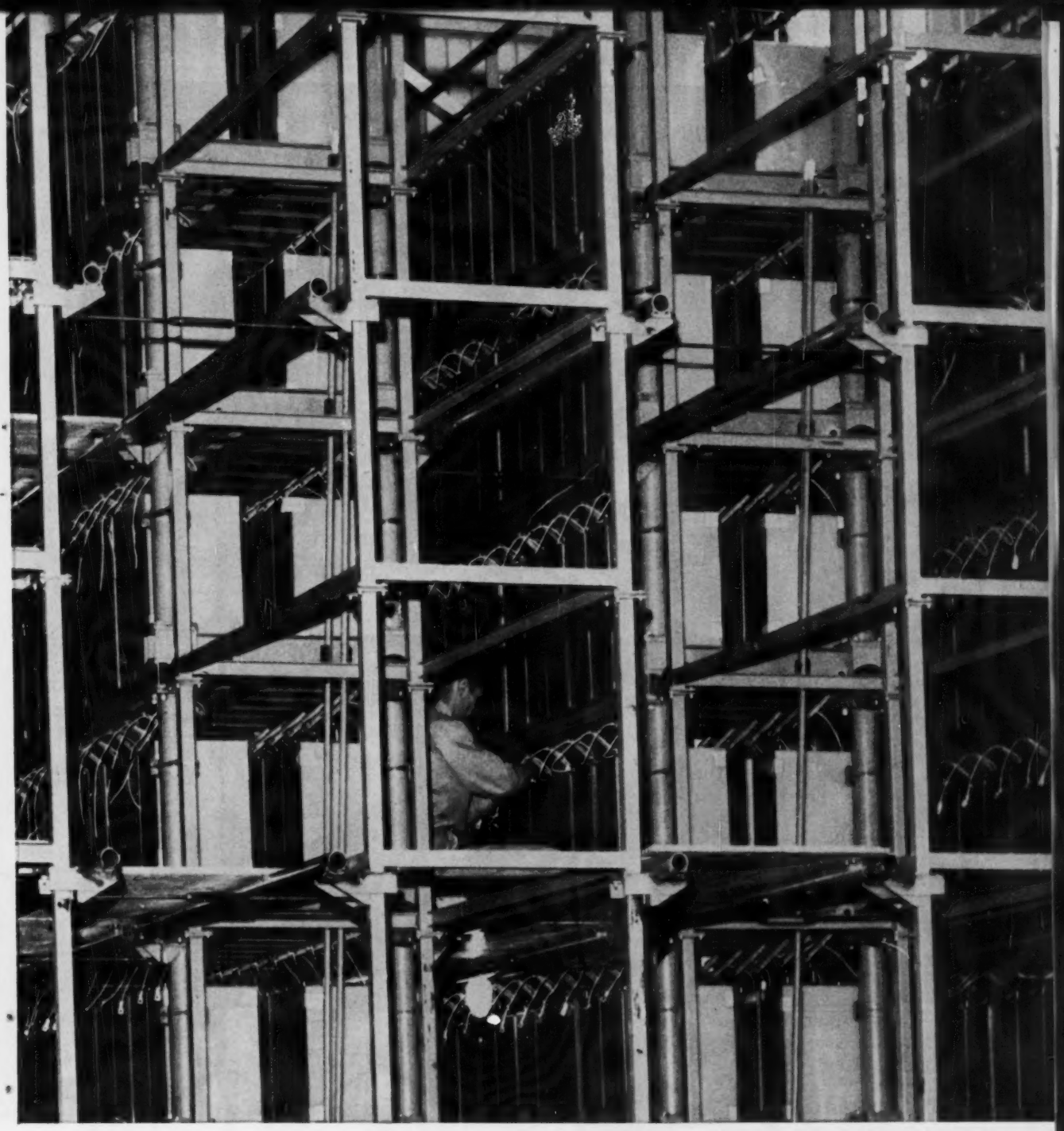

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20	.034"	.012"	5	.186"	.015"
19	.038"	.012"	4	.208"	.015"
18	.042"	.012"	3	.234"	.015"
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16	.053"	.012"	1	.294"	.015"
15	.059"	.012"	0	.330"	.015"
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11	.095"	.012"			

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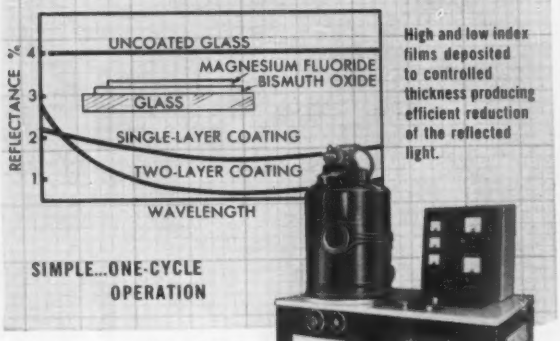

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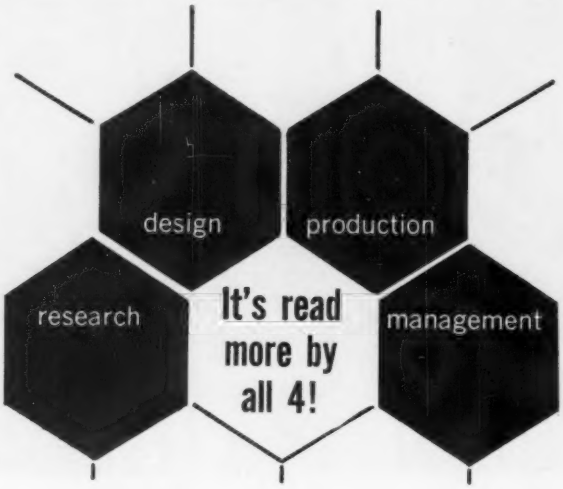

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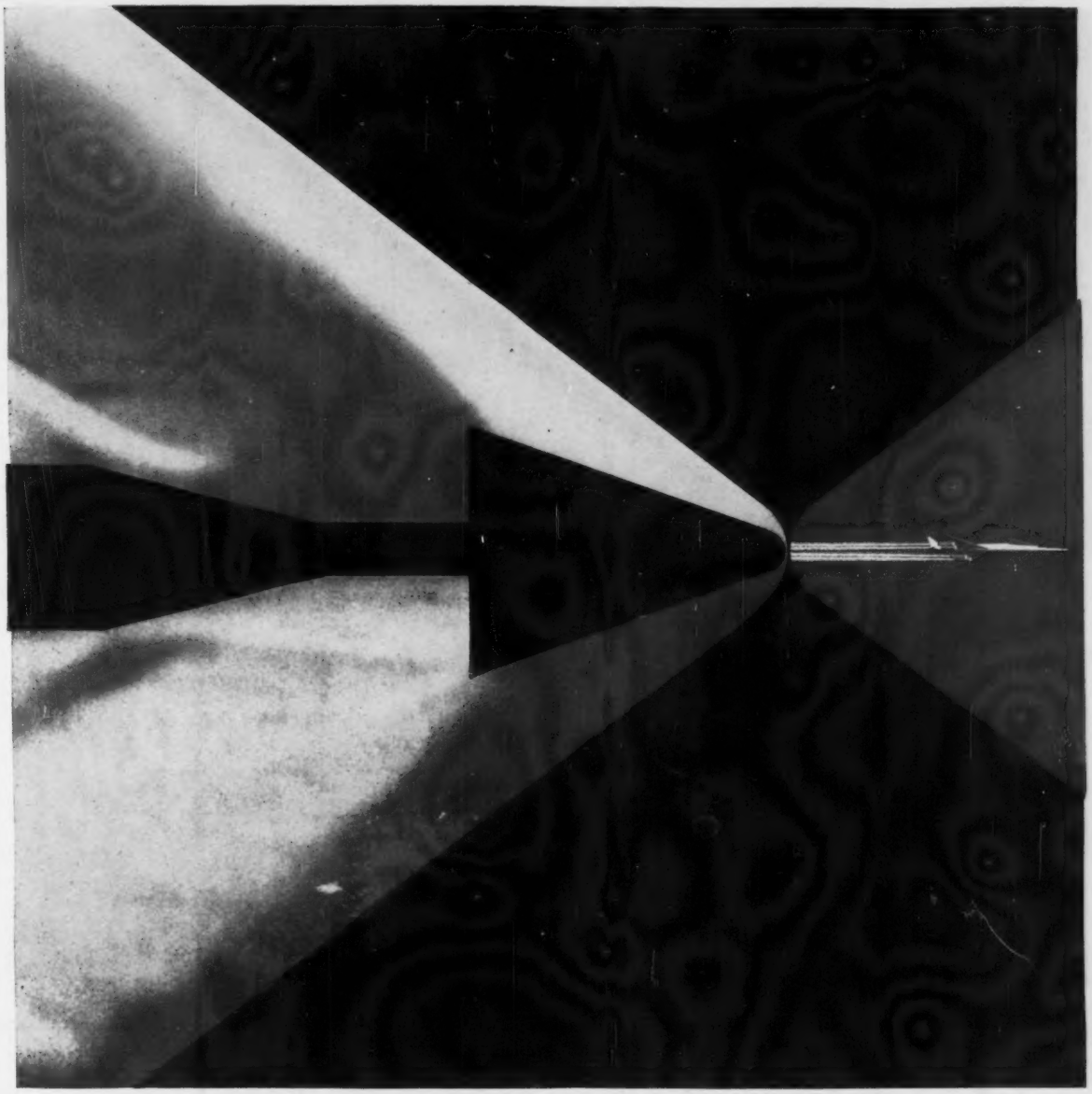

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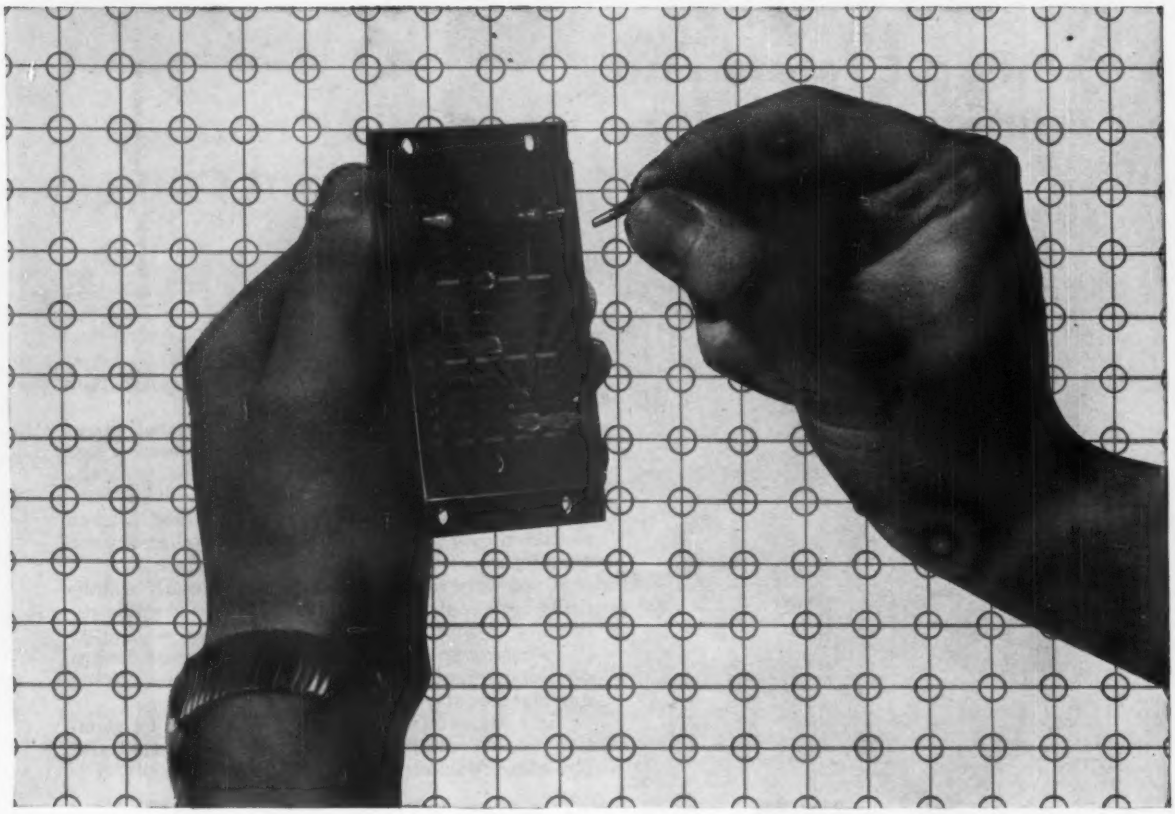

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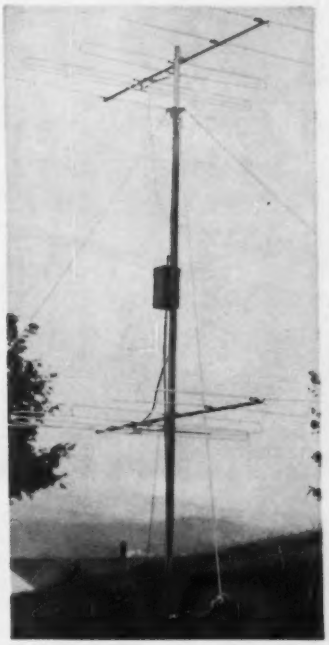


Five-element Yagi antenna on 21-ft mast for 1,000 microvolt per meter field-strength measurements, left, and antennas arranged for 200 and 40 microvolt reception at right

Engineering Performance of Six Proposed Stereo Systems

This fall, the field-test panel of the National Stereophonic Radio Committee filed with the Federal Communications Commission its report on six proposed systems for compatible f-m stereo broadcasting. This article summarizes engineering data relevant to frequency response, distortion, separation, crosstalk and spectrum utilization

By **A. PROSE WALKER,**

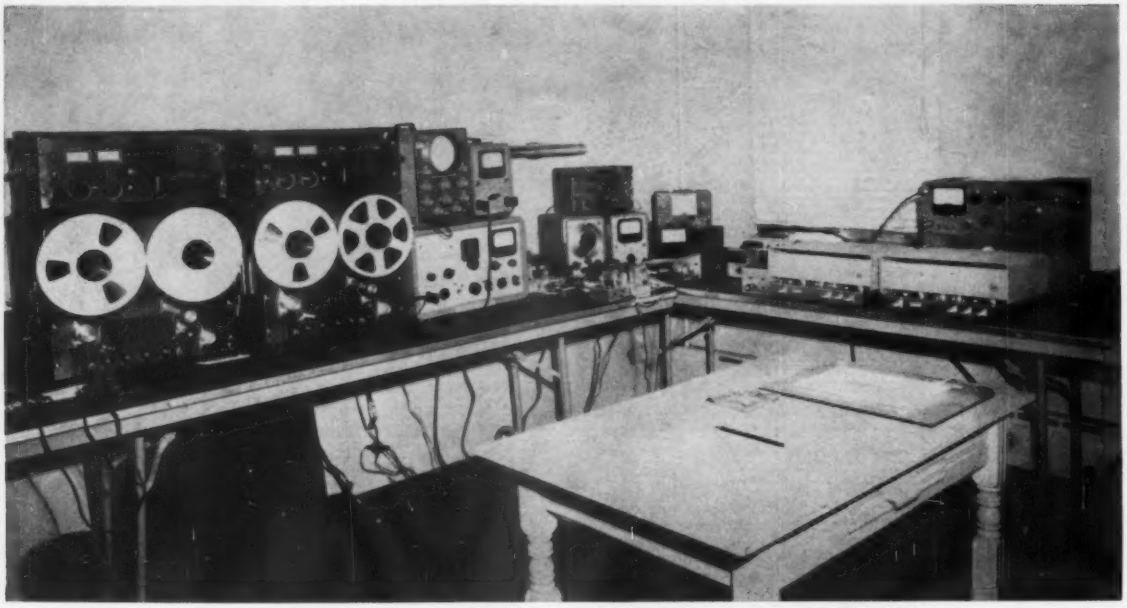
Director of Engineering,
National Association of Broadcasters,
Washington, D. C.

PANEL FIVE of the National Stereophonic Radio Committee was actively organized in March to field test systems for transmission and reception of compatible stereophonic sound over a single f-m channel. The systems to be tested were referred to Panel 5 by NSRC Panel 1. Eight systems were initially referred. Subsequently a system proposed by Philco and one proposed by General Electric were withdrawn by their proponents from field testing.

The six systems tested, by NSRC system number, were: (1) Crosby-Teletronics, (2A) Calbest Electronics, (2B) Multiplex Development, (3) EMI Electronics of England, (4) Zenith Radio and (4A) General Electric.

Six subcommittees were established dealing with: transmitting and receiving site location, specifications for measurements, transmitter and antenna measurements, receiver measurements, data correlation and program material.

Initially it was decided to make measurements at three receiving sites where nominal field strengths



Receiving and measuring equipment used at receiving field site includes tape recorders, distortion analyzer, noise meter, oscilloscope, receivers and other miscellaneous equipment

of 1,000, 300 and 50 microvolts per meter would be obtained and where effects of multipath propagation, ignition noise and airplane flutter might be observed.

Upon making initial observations at the first site, Uniontown, Pa., about 40 miles southeast of Pittsburgh, multipath effects were unusually noticable, resulting in cross-talk from the main to the subcarrier considerably higher than the measured value at the transmitter. The main carrier field strength was in the order of 1,000 microvolts per meter with varying values above and below during daylight and darkness. The antenna used for initial observations was a folded dipole cut to the carrier center frequency (92.9 Mc.) oriented for maximum signal strength, at a height above ground of approximately 21 feet. The predominance of multipath effect resulted in the conclusion to replace the dipole with a 5-element f-m Yagi antenna so that more reliable measurements might be made. The field strength was deduced to be close to that obtained from the dipole but the multipath effects were reduced to a low level. A photograph shows the receiving antenna for the 1,000 microvolt measurements and the bowl-like terrain surrounding the site at the left, antennas arranged for 200 and 40 microvolt measurements, right. Another photograph shows a general view of the receiving-site equipment.

The antenna feed-point impedance was a nominal 300 ohms. A balun was used to convert this impedance to 72 ohms. A coaxial transmission line 200 feet long was branched to the inputs of the receivers to facilitate rapid measurements. Since the receiver inputs were 300 ohms, another balun was connected to retransform the impedance in each branch line from the distribution box to that of the receiver inputs. The measurements made were of the values of signal at the input side of the baluns feeding the receivers, not actual field-strength values. Loss in the receiver baluns is considered negligible. Consequently, the measured value closely approaches the receiver input level in microvolts.

Station KDKA-FM, operating with the call KG2X1U, was used for all transmissions during the field tests. The additional stereophonic equipment was installed in the same room with the f-m transmitter, as will be seen in a photograph. Another photograph shows a general view of the transmitter and the subcarrier generator-exciter that was used for the Subsidiary Communications Authorization (SCA)

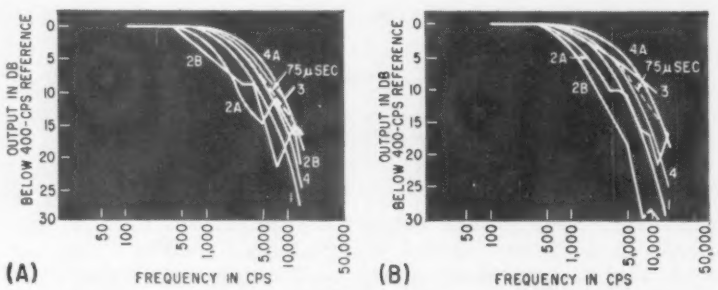


FIG. 1—Frequency response of stereo systems; left channel (A), right channel (B). Response is referred to 400-cps. Transmitter was 100-percent tone modulated with L = R. No preemphasis was used. Dotted line shows receiver deemphasis characteristic

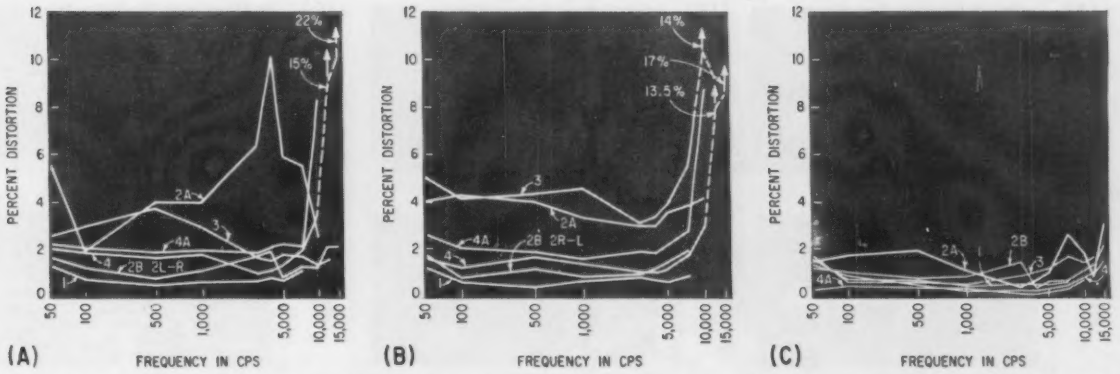


FIG. 2—Percent distortion versus frequency measured at left (A) and right (B) channel outputs and at output of a high-quality monophonic receiver (C). Transmitter was 100-percent modulated with L = R. Distortion meter measured all residual circuit noise as distortion

transmissions as well as for NSRC systems 2A and 2B. The KDKA-TV television transmitter is in the same room as the f-m transmitter. Throughout the tests for varying periods, the television transmitter was in operation. In some cases there may have been energy feed-through from this transmitter into the f-m transmitter.

Measurements made at the transmitter were similar to those at the receiving site, but not so extensive. The spectrum photographs were all made at the transmitter. Probes were inserted in the transmission line feeding the antenna to obtain r-f pickup for measurements.

No difficulty was experienced in making measurements of random signal-to-noise. These measurements were conducted in the usual manner. It was practically impossible, initially, to make significant impulse signal-to-noise measurements using automobiles as the noise generator. It was found that ignition noise was generally so low as to be almost imperceptible, and furthermore it was impossible to obtain any repeatable level. Finally an electric razor was found to be a suitable noise generator. A spot was selected on the 300-ohm line feeding each receiver where the razor was placed in exactly the same manner each time a measurement was made.

Although three sites were initially selected, it was considered most convenient to make all measurements at one site but at reduced field-strength levels. Panel members

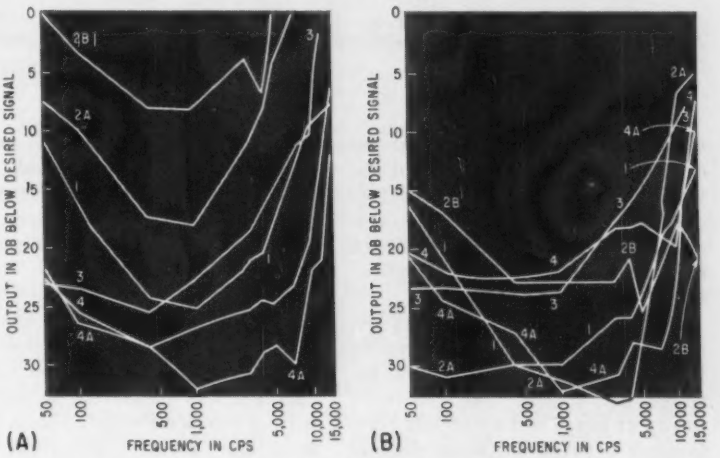


FIG. 3—Separation of left and right channels: output of left channel below right channel with transmitter 100-percent modulated with R only (A): corresponding measurement of right channel with L only transmitted (B). Indicated poor separation may have been caused by faulty equipment

indicated unanimous agreement to experiment with antenna heights to secure approximately the agreed-upon levels of field. Another identical Yagi antenna was procured, and a dpdt switch was installed in the 300-ohm lines feeding the step-down balun between the antennas and the 72-ohm coaxial line. Experiments with the two antennas mounted on the same pole resulted in heights above ground of 40 inches and 10 feet respectively for measured inputs to the receiver baluns of 40 and 200 microvolts.

At the receiving site, data was taken relevant to frequency response, distortion, separation, crosstalk and signal-to-noise ratio. At the transmitter, data was taken on distortion and spectrum distribution.

Frequency response as measured at the receiver site is shown in Fig. 1A and Fig. 1B. It represents the electrical output at the receiver loudspeaker terminals for the left and right channels of each stereo receiver tested. The measurement was made by fully modulating the transmitter with either L = R or L = −R and holding the modulation monitor at the transmitter constant as the frequency of the input signal is varied over the audio range. Only L = R data is shown here.

The curve should show the de-

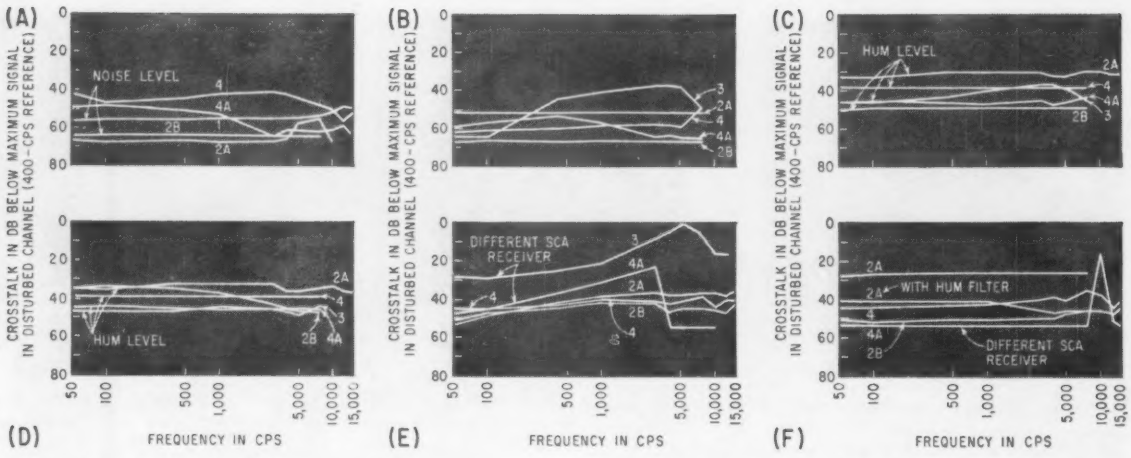


FIG. 4—Crosstalk in decibels below maximum signal that can appear in disturbed channel, 400-cps reference: (A) crosstalk into main channel from stereo subcarrier 100-percent modulated with L = −R, (B) crosstalk into main from SCA subcarrier 100-percent modulated, (C) crosstalk into left channel from SCA, (D) crosstalk into right channel from SCA, (E) crosstalk into SCA with stereo subcarrier 100-percent with L = R and (F) crosstalk into SCA with stereo subcarrier modulated with L = −R. System 3 not measured in (A) and (F); system 1 not measured in (B) (C), (D), (E) and (F)

emphasis characteristic of the receiver since modulation level at the transmitter is independent of frequency. This assumes a flat frequency response characteristic in the transmitter modulation indication.

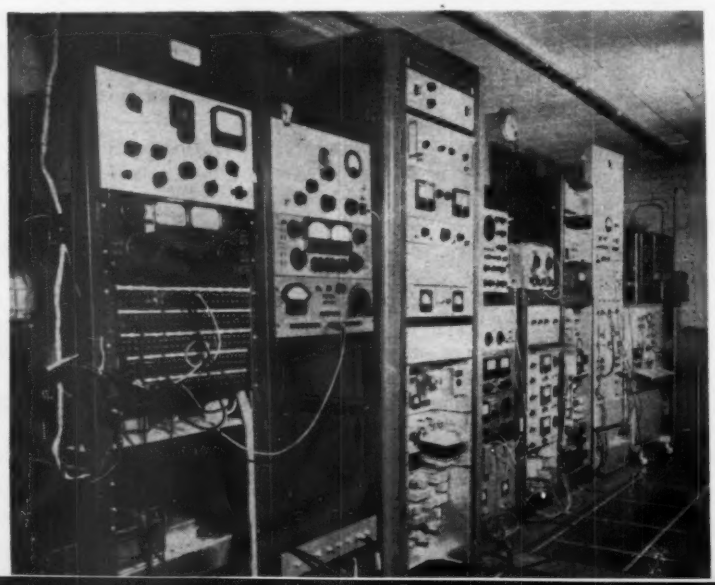
Deviations from the correct deemphasis curve can be accounted for in three ways: incorrect receiver deemphasis time constant; incorrect phase and amplitude relationship between the main channel and subcarrier signal where these signals are matrixed to provide an L or R output or at the high-frequency end of the curve the output decreases at a rate greater than 6 db per octave due to a 15-Kc lowpass filter used at the receiver terminals.

The distortion was measured with R only, L only, L = R, and L = −R transmitted at 100 and 50-percent modulation. In each case two monophonic receivers were measured and each electrical loudspeaker output of the stereo receiver was measured. All measurements were made with equipment that measured all residual circuit noise as part of the distortion. When noise and strong subcarrier components which are fixed are an appreciable part of the reading, the distortion may appear to increase as the modulation amplitude is decreased. Direct evaluation of the effect of the stereo channel or overall distortion cannot be directly derived from these data since monophonic distortion for the stereo receiver was not measured. Figures 2A, 2B and 2C show L = R at 100-percent modulation for left and right outputs and the output of a high-quality monophonic receiver.

The separation of left and right channels was measured by transmitting first a right-only signal and using the output of the right receiver channel as reference while measuring the output in the left channel in db below the right. The same procedure was then repeated in the left channel. In some cases the output of the undesired channel exceeds the direct signal indicating negative separation. This condition might have been caused by a faulty matrix system at the receiver and transmitter. Fig. 3A and 3B show output of left channel with R only transmitted and output of right with L transmitted.

Crosstalk is measured in decibels below the maximum signal that could appear in the disturbed channel. The maximum signal reference is made at 400 cps. In many cases

Proponents' stereo transmitting, measuring and patching equipment installed,



the crosstalk readings may have been limited by residual noise or hum, in spite of the film filter.

Figure 4A shows crosstalk into monophonic channel from stereo subcarrier modulated 100 percent with L equal to −R. Figure 4B shows crosstalk into monophonic channel from SCA subcarrier modulated 100 percent. Figures 4C and 4D show crosstalk into left and right stereo channels from SCA subcarrier modulated 100 percent. Figures 4E and 4F show crosstalk into SCA from stereo subcarrier modulated 100 percent with L equal to R and with L equal to −R.

There were many indications in signal-to-noise measurements that the ratios as measured are limited by quantities other than the inherent noise present in the transmission system. However, the measurements are sufficient to indicate that signal-to-noise ratios better than 40 db in any case are obtainable in all systems operated with at least 50 microvolts per meter field strength and despite some inconsistencies, the theoretical considerations seem to be borne out by the trend established by the measurements.

The oscillographs (Fig. 5) were taken by a 60-second camera using a panoramic receiver. The sweep width is approximately 100 Kc. This can be checked by counting 5-Kc spectrum components. The display is logarithmic with the ½ amplitude spikes 20 db below full scale.

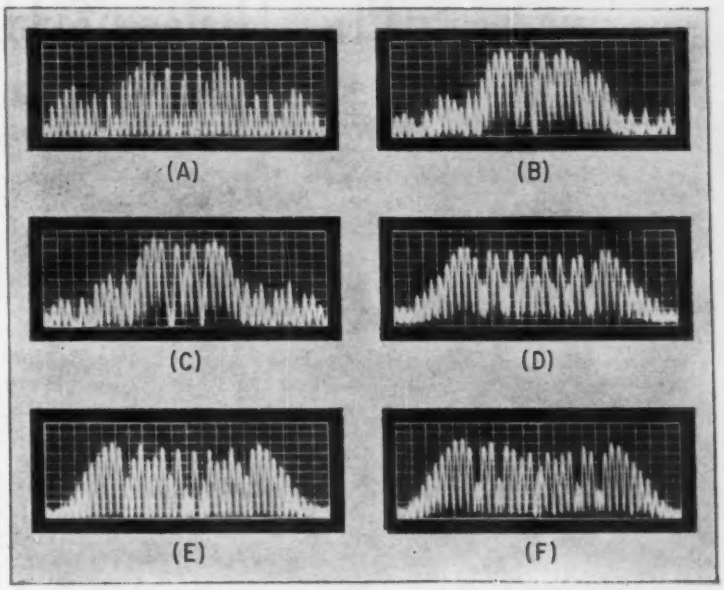


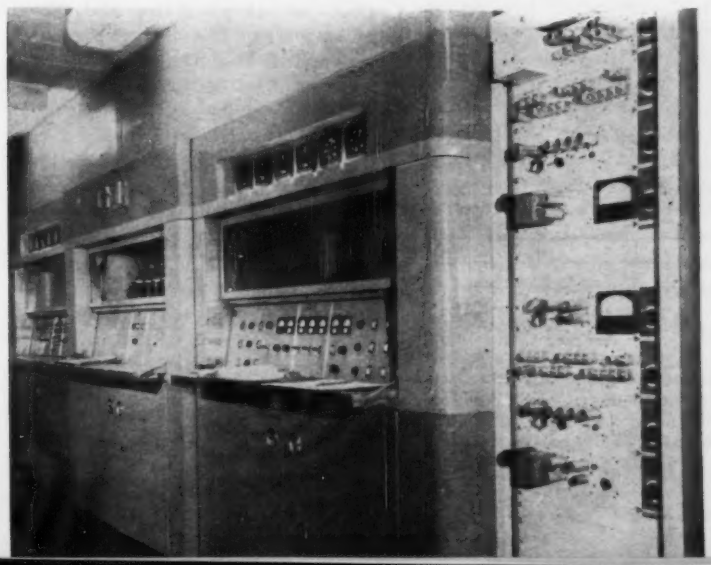
FIG. 5—Spectrum photographs taken at transmitter. Modulation is 100-percent, 5,000-cps tone, L = R. Total bandwidth is 200-Kc. Photos were made by butting two 100-Kc bandwidth spectrums: (A) system 1, (B) system 2A, (C) system 2B, (D) system 3, (E) system 4 and (F) system 4A

Panel 5 was unable to make any measurements in regard to co-channel and adjacent-channel field-strength ratios allowable for satisfactory reception of the desired signal for the six stereo systems tested. Such measurements could be done most conveniently in a laboratory where equipment and controlled conditions may be obtained. It is known that some work has been done in this respect by other organizations.

One of the portions of the system tests performed was an off-air recording of each system made at the three field-strength levels and in some cases at lower field strengths. The stereo program material (also recorded monophonically) was a specially prepared test tape that was used for each such transmission. Each recording contains portions of the test-tape material recorded stereophonically and monophonically. In addition, the fourth track recorded the SCA subcarrier facility using a musical program. The subjective evaluation of these recordings is outside the terms of reference of Panel 5 and the Panel is unable to make such evaluations.

This report contains only field information. The data has been condensed to make its comprehensive and evaluation by the commission easier. No attempt has been made to draw any conclusions that would suggest a recommendation of any one system. The complete report contains an appendix with technical comments made by the systems proponents.

at transmitter, left, and f-m transmitter with SCA subcarrier generator



The Role of High Pressure

New materials are being obtained by transformation, densification and growth under pressures attained by recently developed high-pressure techniques

RECENT TECHNOLOGY has created new methods of generating high pressures. These methods enable researchers to reach pressures of 300,000 bars—1/17 the pressure estimated to exist at the center of the earth. As a result of experiments, new insight is being gained into the action of semiconductors under pressure, the use of pressure for altering physical properties of materials and effects of pressure on the growth of materials.

Formation of a crystalline solid such as germanium can be visualized as the result of bringing N atoms in an orderly three-dimensional array closer together while maintaining their relative positions. As the atoms get close, the electrons, which exist in shells of varying energies outside each nucleus, will interact.

One effect of this interaction is similar to what occurs when two sharply tuned circuits are closely coupled; increasing the coupling broadens the frequency response of each circuit and causes a shift of two initially identical peaks to one slightly below and one slightly above the original peak frequency. When two atoms begin to overlap, the interaction between the shells broadens the energy levels found in the original atom. This effect is depicted in Fig. 1.

At the extreme right of Fig. 1 are shown the energy levels associated with the original widely spaced atoms. As the interatomic distance is decreased, the N originally identical energy levels broaden into bands having N levels each and spaced somewhat apart in energy.

For any given substance, there is a particular interatomic distance characteristic of the substance at normal temperature and pressure. Thus, for a given substance under standard conditions we are not concerned with the complete diagram shown in Fig. 1 but only the part corresponding to the interatomic distance normal for the substance at 1 atmosphere and 20°C. Thus, the section of Fig. 1 giving the proper interatomic distance for standard conditions can be replotted as shown in Fig. 2, where the energy bands are shown, not as a function of interatomic distance, but with the abcissa indicating some direction in the crystal itself.

Figure 2 shows the distribution of energy bands as they might occur in a typical semiconductor. The properties of the semiconductor are determined primarily by the width of the forbidden gap, and whether or not additional energy levels exist in it because of impurities intentionally or unintentionally incorporated in the material. It might be suspected from comparing Fig. 1 and 2 that application of pressure to a semiconductor narrows the forbidden gap by decreasing the spacing between atoms. Surprisingly enough, this is not always the case. In germanium, for example, application of pressure widens the forbidden gap, while the application of pressure to silicon yields only a slight decrease in its gap width. (On the other hand, at pressures above 10^8 bars substances become metallic, which means that eventually the gap must always decrease with pressure.)

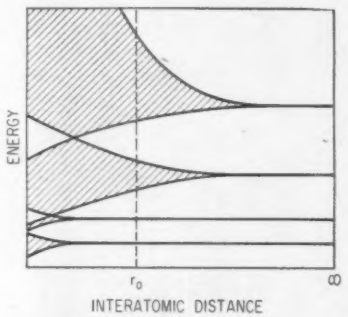


FIG. 1—Energy levels are plotted as distance between atoms with r_0 representing a value of spacing which might be found at normal atmospheric pressure

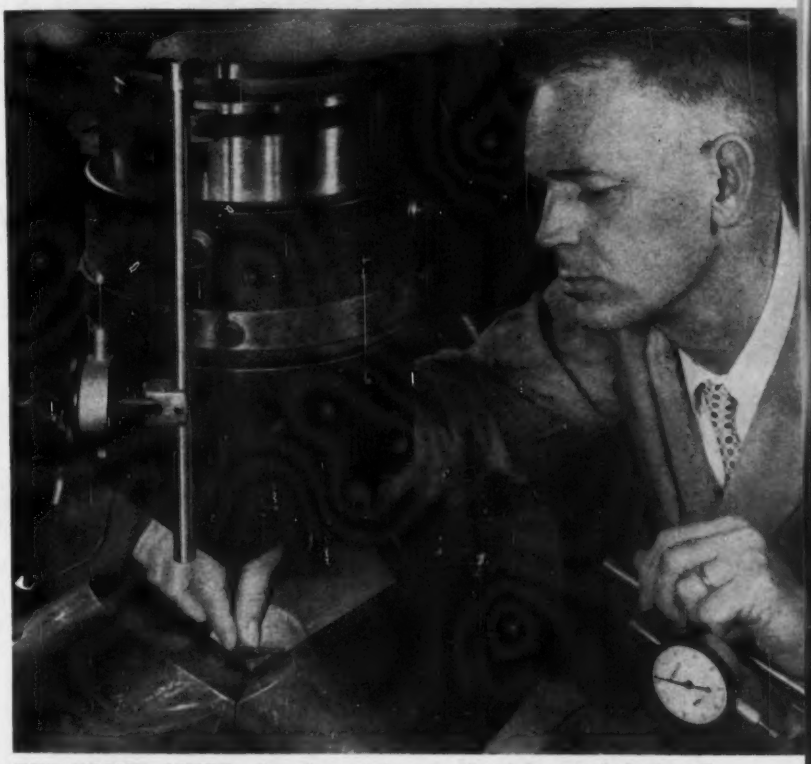
The lowest part of the conduction band in silicon consists of a collection of what are known as (*100*) states, or energy levels. The effect of pressure is to move the energy of these states and those of the valence band closer together; that is, the pressure decreases the forbidden-gap width. In germanium, the bottom part of the conduction band is composed of three types of states: (*100*) states which are similar to those found in silicon, (*000*) states and (*111*) states.

At atmospheric pressure the (*111*) are the lowest states in the conduction band and, hence, determine the forbidden-gap width. Pressure applied to germanium moves the (*000*) states toward increasing energy rapidly. The (*111*) states also increase in energy but at a slower rate. However, as in silicon, the (*100*) states drift only slightly down with increasing pressure. The (*111*) states, which define the bottom of the conduction band at atmospheric pressure, move away, causing the forbidden-gap width to increase. The (*000*) states have no effect on the gap width because they start higher than the (*100*) states and move away faster. If sufficient pressure is applied, however, say between 25,000 and 40,000 bars, the (*111*) states move up so far that the (*100*) silicon-like states now form the lower limit of the conduction band. At any higher pressure, the forbidden gap behaves strikingly like that of silicon. Although there is no direct practical application for this information now, knowledge of this behavior provides considerable information about why silicon and germanium behave electrically and optically as they do even at atmospheric pressure.

Pressure is also valuable as a

In Semiconductor Research

By DOUGLAS WARSCHAUER,
Research Div., Raytheon Co.,
Waltham, Mass.



THE FRONT COVER—Sample container is placed in tetrahedral-anvil pressure apparatus used for high-pressure research at Air Force Electronics Research Directorate Electronic Material Sciences Laboratory

physical parameter for research. Pressure and temperature are fundamental physical variables. Measurement of silicon and germanium as a function of temperature involves two things—a change of interatomic spacing because of expansion due to temperature, and a change in the extent to which many of the physical processes occurring within the substance are activated by the temperature change. Pressure as a tool of investigation allows the effects due to a change in interatomic spacing to be observed alone.

Knowledge of the behavior of germanium and silicon, for example, correlates very well with observations on the alloys of these elements. Adding silicon to germanium and producing a single crystal from the resulting solid solution gives a substance whose behavior is interpretable in terms of what is known about the two materials separately.

If one adds silicon to germanium, the forbidden-gap width of the alloy increases (with increasing silicon content) from that of pure germanium to that of pure silicon. This effect is linear up to 18-percent silicon in germanium, at which concentration an abrupt break occurs; above 18 percent the change is linear, but with a smaller slope.

The interpretation of this effect is that below 18 percent the forbidden-gap width is determined by the position of the (*111*) germanium conduction-band states, but as silicon is added these states move away from the valence band, finally exposing the initially higher-lying silicon (*100*) conduction-band states at about 18-percent composition. Above this composition, the gap behavior is determined by the (*100*) states, with the addition of more silicon having the effect of driving these states upward.

When pressure is applied to an alloy, it is found that alloys below 18-percent silicon behave in a germanium-like fashion with respect to the variation of gap with pressure; above 18 percent the pressure variation is like that of silicon (smaller) and in the opposite direction to that of germanium. At precisely 18 percent the pressure variation is zero, just what is expected when the two sets of states are exactly the same distance from the valence band. Thus, pressure measurement verifies the changeover thought to occur in these alloys.

The intermetallic semiconductors are binary alloys of one element from each of the two columns of the periodic table flanking the carbon, silicon and germanium column. These alloys have behavior predictable in terms of the behavior of carbon, silicon and germanium themselves. In fact, there is a correlation between altering the lattice constant through pressure and through alloying, so that alloying may be regarded as providing a built-in positive or negative pressure, as was shown by silicon-germanium alloys. Properly selected intermetallic alloys can give pressure behavior almost identical to their closest elemental relatives in the periodic table.

Other work on the effect of pressure on impurity levels in the forbidden gap and on the characteristics of Esaki diodes has yielded considerable information. The normal rectification characteristic of a diode is given by the well-known relation $I = I_s [\exp (gV/kT) - 1]$ where q is the charge of the electron, V is the voltage applied to the diode, k is Boltzmann's constant and T is the absolute temperature of the diode. The constant

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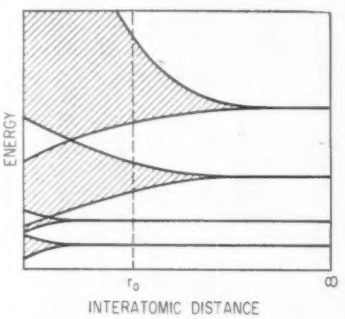

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I_s is known as the reverse saturation current—the small thermally-generated current which flows when the rectifier is strongly reverse biased. The logarithm of I_s is proportional to the forbidden-gap width of the semiconductor used, providing the temperature does not get too high. More specifically, the diode equation can be written as

$I = A \exp(-E_g/kT)\,[\exp(qV/kT) - 1]$

where A is roughly a constant. It is now easy to see that if constant current is passed through the diode at a fairly high voltage in the forward direction, that is, where the exponential in the bracket is large compared to one, and the voltage across the diode is measured as pressure on the diode is varied, $q\,dV/dp = dE_g/dp$.

In other words, the voltage change will be proportional to the change in forbidden-gap width with pressure. This relationship, which was developed and used some years ago for one of the first measurements of the gap shift in germanium, was measured again recently[1] in the large-forward-bias region of a germanium Esaki diode. The voltage dependence turned out to exhibit exactly the pressure dependence of the forbidden-gap width found earlier in bulk germanium. The curve follows the behavior of the (*111*) states moving away at lower pressures, while at higher pressures the more stationary (*100*) states begin to have their influence. The agreement is excellent, almost too good, because other parts of the Esaki diode characteristics[2, 3] exhibit peculiarities which aren't understood at this time even at normal atmospheric pressure. These other quirks are being investigated as a function of pressure too, in the hope of understanding how they arise.

The use of high pressure to remove voids in sintered or compressed, ceramic or metallic, materials may lead to denser or stronger materials with better electrical properties than are now available.

Use of high pressure to convert normally insulating or semiconducting substances to metals is not practical at this time, because of the extremely high pressures required and because the reactions are reversible. Transformations of other types, however, are possible in solids. Although relatively few solids have been investigated, there is some chance of developing new materials by this means. A solid may have a stable arrangement of atoms which nonetheless can be changed into another configuration by application of pressure. The new form may not necessarily revert to the original when the pressure is removed; such a transformation is an irreversible change

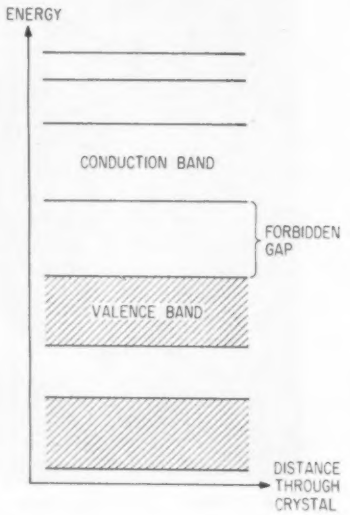

FIG. 2—Energy levels in a typical pure semiconductor

of state and the new state may have radically different properties from the original state.

For example, if ordinary white or yellow phosphorus is subjected to a pressure of about 12,000 or 13,000 bars with a temperature of 200 C, the phosphorus is converted to a black form, much like graphite in appearance and with a density of 2.67 compared to 1.9 for yellow phosphorus. The material is stable; at atmospheric pressure and temperature and sealed in glass to prevent oxidation, it can be kept indefinitely without change. More interestingly, this material is a semiconductor, while the other forms are not. R. W. Keyes has found that the energy gap at room temperature is about 0.33 electron volt, smaller than that of germanium, which is 0.65 electron volt. Measurement of the electron and hole mobility in his samples, all of which turned out to be *p*-type, yielded 220 cm^2 per volt-sec and 350 cm^2 per volt-sec, respectively.

These properties as they stand make black phosphorus of little use except possibly for transistor devices which operate only at sub-zero temperature (for which there is no known demand). Since this is possibly the only new semiconductor stemming from high-pressure work to date, it cannot be said that high-pressure investigations have led to materials of use to electronics engineers, but the possibility of a future development should not be discounted.

Interest in high pressure has boomed since 1955 when General Electric announced the successful growth of diamonds under pressure. The main application of synthetic diamonds has been to grinding material; however, doping studies are underway. Such studies may lead to the ability to make *n*-type and *p*-type diamond, and possibly even *p-n* junctions. Thus, diamond might have value as a high-temperature semiconductor, although its rather low decomposition temperature and high cost probably would limit its utility.

Yet another material grown under high pressure is a cubic form of boron nitride, which is as hard as diamond and more stable. Furthermore, boron nitride is probably a semiconductor, though little has been done to investigate its properties. Garnets and other minerals have been grown under high pressure also.

Not only are extremely high pressures of value in producing new materials or materials not previously grown by man, but moderate, or even low pressures, can aid crystal growth, particularly in attempting to grow materials known to sublime rather than melt when heated at atmospheric pressure. Zinc sulfide and cadmium sulfide have both been grown under pressure.

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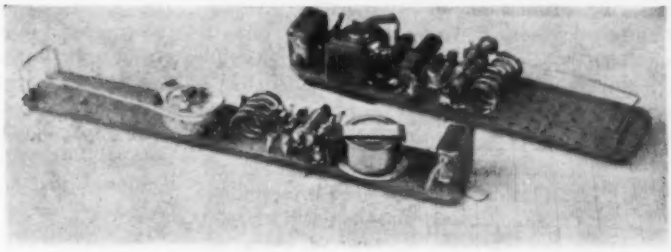
Tunnel Diode F-M Wireless Microphone

Unit operates in the conventional f-m band with a range of 50 to 100 feet. In this multifunction circuit the tunnel diode is also the a-f amplifier

The author wears the f-m wireless microphone clipped on a pocket during a classroom lecture



The longer of the two tunnel diode microphones is the model with two diodes in cascade; the shorter one has a single diode

By WEN-HSIUNG KO,
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THIS F-M oscillator-modulator unit using a single tunnel diode is capable of producing a 35-Kc frequency deviation per mv of modulating signal without any variable reactance element. The tested 90-Mc f-m unit, fed from a dynamic microphone, has a range of 50 to 100 feet. The total unit including battery and microphone can be packed in 3 × ½ × ½ inch. In the laboratory model the same tunnel diode is used as the audio frequency amplifier. A gain of 3 to 5 can be obtained.

Besides the many desired properties of tunnel diodes, such as high speed, wide band, and compactness, it differs from other electronic active devices in that it is a two-terminal bilateral element. It is a negative-resistance device with no preferred direction of signal flow. This unique property is commonly thought of as undesirable. For example, in amplifiers and switching circuits this presents the difficult problem of coupling and isolation of output from input. However, this property can be used advantageously to obtain multifunction circuits. In a converter a tunnel diode can be used as an i-f amplifier, local oscillator, mixer and l-f amplifier[1, 2]. In an oscillator, a tunnel diode may be coupled to two or more resonant circuits to produce oscillations of different frequencies and their beats[3, 4]. The multifunction circuit is another avenue toward miniaturizing electronic equipment.

However, a closer look at the possibility of devising multifunction circuits indicates that, again, the separation of signals into different functions is the great problem. Unless the mixing of signals is desired, or the signals can be separated by established techniques, the multifunction circuit will remain an avenue with a big detour

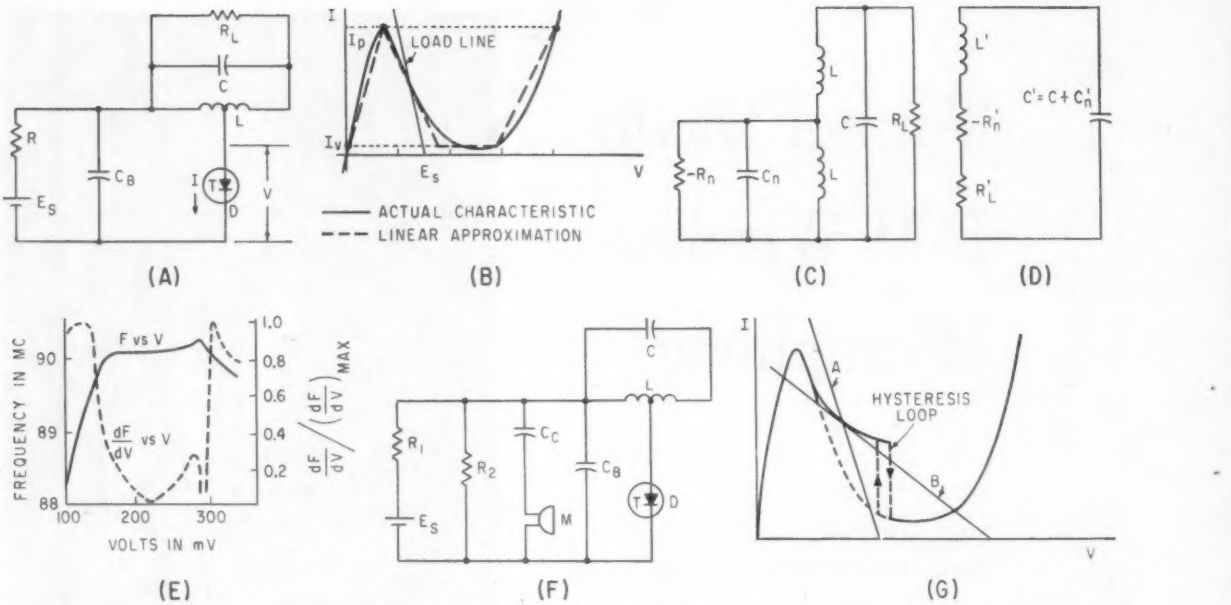

FIG. 1—Tunnel diode oscillator circuit (A); tunnel diode static characteristic (B) equivalent circuits of the tunnel diode oscillator (C and D); frequency and dF/dV plotted against bias (E); modulator circuit of f-m oscillator (F); and d-c characteristics of a tunnel diode oscillator; the dashed curve indicates the characteristic with no oscillation (G)

sign. Since the separation of signals with large frequency difference is a well-known technique, multifunction circuits involving signals of different frequencies would be possible with the present technique. Converters and tone-modulated r-f oscillators are the two examples that agree with this reasoning. Modulators, the reverse operation of the converter, also satisfy the above requirement. Research on tunnel diode a-m and f-m circuits proves that multifunction circuits for modulators are possible. This article will discuss the circuits to produce an f-m signal with a single tunnel diode.

The oscillator circuit shown in Fig. 1A consists of the d-c supply, the resonant circuit, and the tunnel diode D. The d-c supply should bias the diode D in its negative resistance region and R should be smaller than the value of minimum negative resistance of the diode, R_n. The static characteristic of the tunnel diode and its sectional linearized approximate characteristic are shown in Fig. 1B, together with the d-c load line. The a-c equivalent circuit of the oscillator using the linearized characteristic is shown in Fig. 1C, which in turn can be simplified to the series resonant circuit in Fig. 1D. Here the R_L, R_n, and C_n are no longer constant but functions of frequency. At the resonant frequency of the circuit $f_o = 1/2\pi\sqrt{LC}$ if $|R_n'| = R_L'$ the circuit will have an infinite $Q = 1/R_t\sqrt{L/C}$, where $R_t = R_L' + (-R_n') = 0$. If the oscillation is started it will be sustained. If $|R_n'| > R_L'$ the oscillation will grow until it is limited by nonlinearities that will reduce the average R_n over a cycle of oscillation to the value of R_L.

The first case is not a stable one. If R_L' is varied due to a change of surroundings the oscillation will decay and finally die. The second case includes most of the practical oscillators. However, the frequency now will be smaller than f_o. The parameters determining the actual frequency will be: (1) L and C, (2) R_L or R_L' (including the losses in coil, capacitor and radiation), (3) R_n and C_n (or R_n' and C_n'), and (4) the nonlinear characteristic of the diode in the range of voltage and current swing of existing oscillation.

The first set of parameters is the one most commonly used to vary the frequency of an oscillator. It requires controllable reactances. The second set is generally considered as a perturbance rather than a controlling factor. The third and fourth parameters depend on the type of tunnel diode used. For a given diode they are bias-sensitive. It is reported that C_n decreases with increasing bias in the negative-resistance region of germanium tunnel diodes[5]. If R_n and the nonlinearities remain constant, the frequency should increase with increased bias. This general tendency is verified experimentally, but it is believed that the nonlinearity of the positive resistance region of the tunnel diode characteristic has an important role in determining the relationship between frequency and bias voltage.

An experimental test of the circuit in Fig. 1A verified the above reasoning and indicated that the frequency is strongly dependent on bias. The data obtained from an 89.4-Mc oscillator using a General Electric 1N-2941 1-ma tunnel diode is represented by the curves in Fig. 1E. The solid-line curve is the frequency-bias relation. The dashed-line curve is the approximate relationship between dF/dV and bias. It is observed that for maximum frequency stability the diode should

be biased near 0.21 v, while for maximum dF/dV, the diode should be biased at 0.13 or 0.3 v. In both cases the dF/dV is about 35 Kc/mv. Near 0.13-v bias, dF/dV is nearly constant, but near 0.3-v bias dF/dV drops off sharply from both sides.

Based on the study of the experimental data, an f-m oscillator-modulator circuit was designed and is shown in Fig. 1F. The parallel combination of $R_1 - R_2$ is less than the value of the negative resistance of the tunnel diode and the diode is biased at 0.13 v. A modulating source or a dynamic microphone, M, is connected across the bias circuit through the blocking capacitor C_c to provide the modulating signal. The microphone converts the sounds into a voltage across the bias resistance, and by means of the tunnel diode produces the frequency deviation.

The f-m is produced by the variation of bias voltage. The dF/dV is not frequency-sensitive. This circuit should be able to give uniform modulation over a wide band until the stray capacitance in the circuit alters the effective dV applied to the tunnel diode. However, the dF/dV is bias-sensitive. It is sensitive to the amplitude of the modulating signal. If the bias is properly selected it has the effect of a compressor in that for high-level signals the average dF/dV will be smaller than the dF/dV produced by low-level signals.

When the $R = R_1R_2/(R_1 + R_2)$ is properly selected, the tunnel diode acts as an audio-frequency amplifier. The current gain is $R_n/(R_n - R)$ if the source has a high impedance and is connected in parellel with R and the diode[5]. If R_n is nearly equal to R the gain can be large. However, in the present case, the gain cannot be made large because when oscillation is present the static characteristic changes as Fig. 1G shows[3]. Resistance R_n is now different from (larger than) the value measured without oscillation. If the circuit is designed to give high audio gain, the load line B in Fig. 1G will cross the tunnel diode characteristic at more than one point. The oscillations may not be stable. When the audio signal is large, the amplified audio may swing the operating range out of the oscillating region and the oscillation would stop. When the input signal is limited to small values a gain of 5 is obtainable from the tunnel diode.

For practical applications the dynamic range of audio signals should be large. To secure reliable stable operation the a-f amplifier function of the tunnel diode is not used to its full capacity. A transistor is used to amplify the audio signal and at the same time to provide the bias for the tunnel diode. The tested circuit is shown in Fig. 2A. A 1-ma germanium tunnel diode is used with a three-inch antenna. Coil L is about 6 μh, wound of No. 18 silver-plated wire with seven turns in one inch, and one-quarter inch in diameter. Capacitance C is an 18-pf fixed, in parallel with a 10-pf adjustable. The unit has a range of about 50 feet with little noise. The frequency response measured from the output of a tuner with, as well as without, a de-emphasis circuit is plotted in Fig 2B. If pre-emphasis is desired, the diode 1N34A in Fig. 2A may be replaced by the R_1C_1 parallel circuit shown by the dotted lines. The R-C time constant should be 75 μsec. When the input impedance of the transistor stage is z_i, and the output impedance of the microphone is z_o, then in order to have a 15-Kc bandwidth between the 3-db points, R_1 should be equal to $9(z_i + z_o)$. For a smaller bandwidth the value of R_1 may be reduced, keeping the R_1C_1 product at 75 μsec.

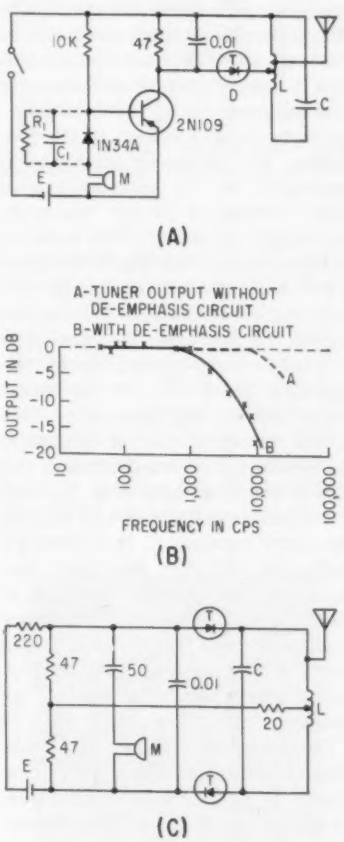

FIG. 2—Circuit of f-m wireless microphone (A); frequency response of the f-m loop; and circuit of the cascade oscillator and f-m modulator (C) using two tunnel diodes

A test was performed to check the reasoning discussed previously concerning the dF/dV-bias relation. An audio tone was kept at a constant amplitude of 5 mv peak-to-peak and constant frequency of 1,000 cps. The bias was varied from 0.1 to 0.32 v. The relative output of the tuner was recorded and plotted in Fig. 1E. The experimental results checked well with the dF/dV curve obtained from the frequency bias curve.

An oscillator with an inductance in series with the main tank circuit was also tested and found to give satisfactory results. To increase the r-f output and to extend the radio range, an oscillator using two cascade 2-ma germanium tunnel diodes was built with performance comparable to the single tunnel diode circuit and with a range of over 100 ft. Its circuit diagram is given in Fig. 2C. Coil L is about 5 μh, half an inch long and a quarter inch in diameter, with five turns. Capacitance C is a 45-pf trimmer set at 24 pf.

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Designing Antennas to Include

Parametric amplifier is incorporated within cylindrical half-wave dipole antenna. Received signal can be amplified at point of interception and output made available in shielded, balanced or unbalanced, low-impedance transmission line

By ALBERT D. FROST, Director, Antenna Systems Laboratory, University of New Hampshire, Durham, New Hampshire

EFFECTIVE TRACKING of satellites and space vehicles using Doppler shift techniques requires adequate received signal strength. Of more importance than the absolute signal level is the ratio of signal to total noise present in the receiver output.

In an effort to eliminate the component of total noise due to internal receiver noise, the Antenna Systems Laboratory of the University of New Hampshire has been developing several forms of parametric amplifiers suited to tracking applications at frequencies used by U. S. satellites and space probes. In particular, efforts have been toward using stripline circuit techniques.

Initial work resulted in several preamplifier models for use above 200 Mc employing a design based on the Harris amplifier,[1] which uses a shorted quarter-wave line section to provide the required resonant region. However, at 108 Mc the etched circuit device was inefficiently large and unlikely to provide a competitive unit.

It was at this point that the concept was evolved of incorporating the parametric amplifier configuration within a cylindrical half-wave dipole and providing the required resonant regions internally by adding a coaxial center conductor as shown in Fig. 1B. The outer cylinder is the dipole antenna and acquires the signal. At resonance it provides an alternating charge concentration at the ends.

Variable reactance elements between the outer cylinder and the inner coaxial region are in the form of voltage-variable capacitances produced by reverse-biased 1*N* 894 or HPA2800 diodes.[2] The inner region exhibits a family of *TEM* resonances corresponding to the relatively high-impedance transverse boundary conditions at each end of the dipole. The mode of operation is that in which the output signal is derived at the same frequency as the input signal f_s. Variation in the reactance element is produced by a large amplitude pumping signal f_p. A resonance region must also be provided for the so-called idler component, f_i, at $f_i = f_p - f_s$.

As shown in Fig. 1B, the center conductor is divided into two halves with a thin insulating layer between the sections. This electrical separation is necessary to permit separate bias adjustments of opposite polarity to be made for each of the two diodes. The lowest or fundamental resonance of the interior region must correspond to the operating or signal frequency. The location of this resonant condition is established basically by the length and propagation constant of the coaxial region. In this case the location is also influenced significantly by the shunting reactance of the parametric diodes, the dielectric effect of the center conductor supports, the impedance reflected through the output coupling loop and the net series reactance across the gap in the center conductor. It is through control of the latter reactance that the necessary tuning adjustment is made. A pumping signal is applied in phase to both diodes through the center conductor by a twin-contact coaxial connector (UG-103A/U) indicated as P_1 in Fig. 1B.

The complete network is shown schematically in Fig. 1C. The branch L_s C_s is series resonant in the vicinity of f_s and by adjustment can provide a positive or negative impedance to yield a net gap impedance for cavity resonance at f_s. Bias is applied through inductors L_B which are self-resonant at f_p. Capacitors C' serve as r-f bypass paths. The pumping frequency is selected to correspond to an even-order resonance mode such as the sixth. Due to the influence of the shunting end-capacitance and, to a slight extent, the gap reactance, this mode is located at a frequency somewhat below $6f_s$. Adjustment of the fifth order *TEM* resonance to equal $(f_p - f_s)$ is accomplished by adjusting the L_i C_i branch so that the combined effect of these elements and the others in this network provide the appropriate gap reactance at f_i.

The signal output is extracted by a loop oriented to enclose a portion of the circumferential magnetic field within the coaxial region. Stripline sections external to the resonant region connect the ends of the loop to a twin coaxial contact plug P_2. These sections can also serve for impedance transformation or incorporation of an idler frequency filter array. It is important that the idler component circulate in a resonant region having minimum losses since the presence of such loss will result in reduced gain and increased self-noise in the output. These losses can arise from resistive losses, radiation or the extraction, and subsequent dissipation, of a portion of the idler through coupling to the signal output loop.

To reduce the last mentioned loss mechanism, the output loop is constructed with an effective length equal to a full wavelength at the selected idler frequency. If necessary, a low-pass filter with its cutoff frequency above f_s can be included in the output line which should be terminated so as to reflect a matched resistive load into the coaxial cavity at the signal frequency.

Parametric Amplifiers

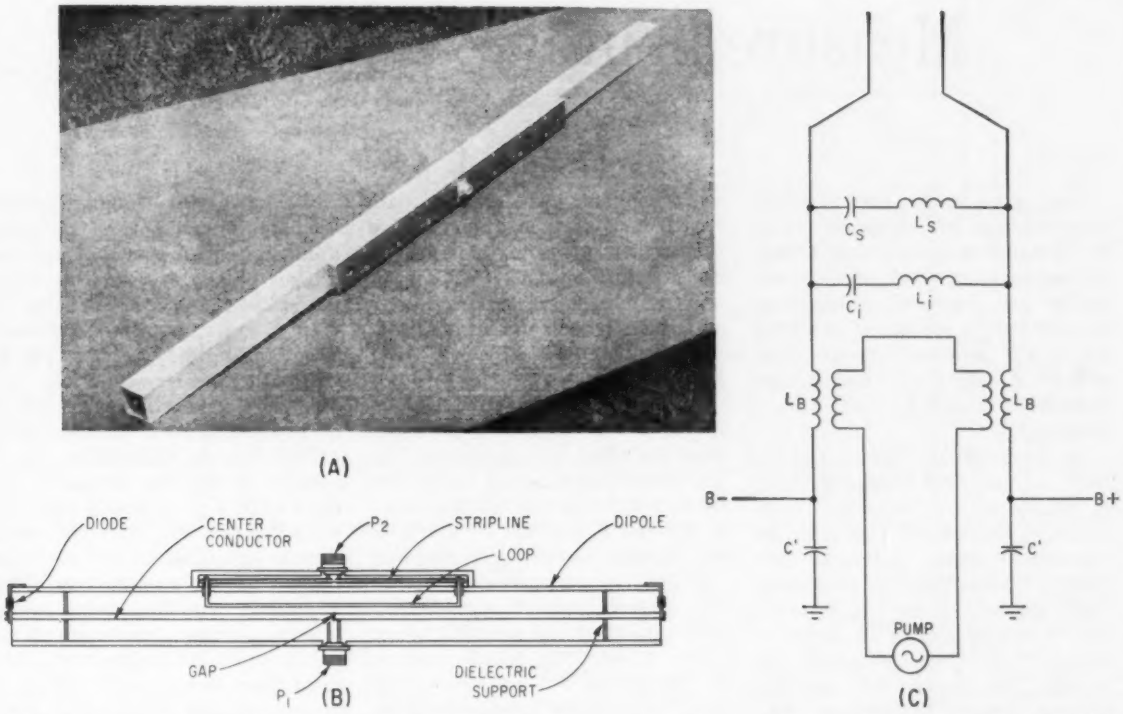

FIG. 1—Parametric amplifier antenna for 108 Mc (A) has coaxial center conductor and output coupling loop (B); coupling network (C) between pumping signal source and midpoint gap in center conductor includes bias connections and tuning elements for adjusting required cavity resonances

In a controlled negative-resistance device with an input and output at the same frequency, care must be exercised to hold the pump level at the minimum required to achieve desired gain and to optimize the location of the pumping signal frequency and the idler as discussed above. A typical curve of gain of a parametric amplifier antenna over a passive dipole of the same length is shown as a function of frequency in Fig. 2.

Simultaneous application of a forward bias to each parametric diode results in a decrease in amplifier gain of 40 to 50 db. This is due to inhibition of the parametric amplification action and detuning of the interior resonant cavity. By superimposing a switching wave on the operating bias, it is possible to switch or gate an amplifier at a periodic rate or to selectively switch a group of such antennas in a desired sequence. The switching waveform amplitude must be sufficient to produce low forward resistance (the OFF condition) while not exceeding maximum current limitations. Initial experiments have used switching rates up to 20 Kc, and at that point appear to be limited in effectiveness only by the bandwidth of the associated receiver.

In summary, the parametric amplifier antenna permits amplification of a received signal directly at the point of initial interception, either as a dipole or as the signal collecting element in a Yagi, disk-on-rod or other surface-wave array or at the focus of a parabola. The bias requirements for the diodes present a means whereby the antenna amplifier can be switched on or off as desired. An unmodulated input signal can be chopped at a selected rate for filtering and synchronous detection in the associated terminal equipment.

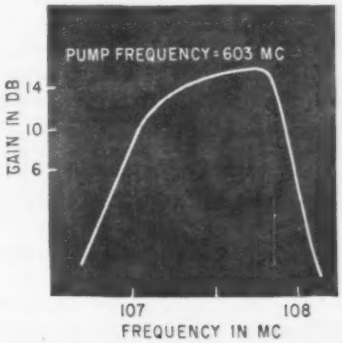

FIG. 2—Gain relative to that of passive dipole designed for 108 Mc

Other forms of these antennas using quarter-wave dipoles or dual ground-plane slots are now under investigation.

The author appreciates the contributions made by R. R. Clark and R. Harrington. This work was carried out under the sponsorship of the Air Force Cambridge Research Center, Electronics Research Directorate.

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Precision Ultrasonic Velocity Measurements

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ONE TECHNIQUE for precision measurement of ultrasonic velocity in liquids and solids uses a sing-around system. This article describes an improved sing-around system[1] that is capable of detecting ultrasonic velocity changes two orders of magnitude smaller than possible with previous sing-around systems.

In the original sing-around system[2], an electrical transmit signal is applied to an ultrasonic transducer on one side of a sample. An ultrasonic signal traverses the sample, striking the receiving ultrasonic transducer on the opposite side, which generates an electrical signal. This electrical signal retriggers the transmitter and the process repeats indefinitely. The time required for a large number of sing-around cycles is measured with an electronic timer, while an electronic counter counts the number of sing-around cycles. By subtracting the electronic delay from the total delay, the acoustic travel time is obtained, which for a given sample thickness determines velocity. A small change in travel time is detectable because it is multiplied by a large known number in the process of being measured. This system is capable of detecting velocity changes of about 2 parts in 10^5 or larger. The present system detects velocity changes of about one part in 10^7 or larger.

A block diagram of the system, excepting the timing circuits, is shown in Fig. 1, with explanatory waveforms. Ten-megacycle quartz crystals function as ultrasonic transducers. Instead of using the leading edge of the first acoustic through-pulse, gating circuits select a particular cycle of a particular echo to retrigger the transmitter[3]. This procedure results in a large ratio of acoustic delay to electronic delay in a sing-around cycle, minimizing the effect of electronic delay variations; it increases the path length and relative attenuation of echoes from preceding sing-around cycles, preventing interference; and permits a fast-rising large-amplitude trigger to be obtained, minimizing effects of noise, jitter and drift.

A tandem delay circuit is used rather than a single delay, to minimize the effect of delay instability. The narrow gate, which selects the desired cycle in the selected echo, is delayed a fraction of a microsecond with respect to the leading edge of the selected echo rather than several tens of microseconds with respect to the transmit pulse.

The transmitter which appears in the dashed box on the left in Fig. 1, is shown schematically in Fig. 2A. The free-running blocking oscillator is not part of the sing-around circuit proper, but provides trigger pulses on open-loop operation while the operator adjusts the delay circuits for proper operation. The transmitter uses a Philips EFP-60 secondary-emission pentode in a regenerative pulser circuit to produce a 20-v, 35-nsec pulse.

The trigger generator, which appears in the dashed box on the right in Fig. 1, is shown schematically in Fig. 2B. Electrical echo signals generated by the receiving transducer are amplified in a 10-Mc tuned amplifier, then passed into the trigger generator. Sync pulses from the transmitter, derived from the transmit pulse, are passed through an external delay

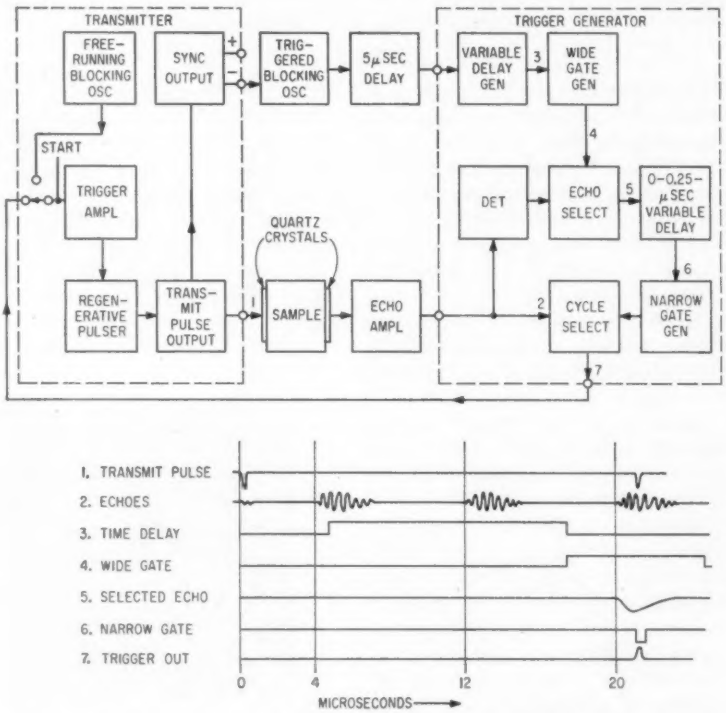

FIG. 1—Each number in the block diagram of the sing-around system refers to the signal at that point, as shown by the waveforms. The timing circuits are not shown

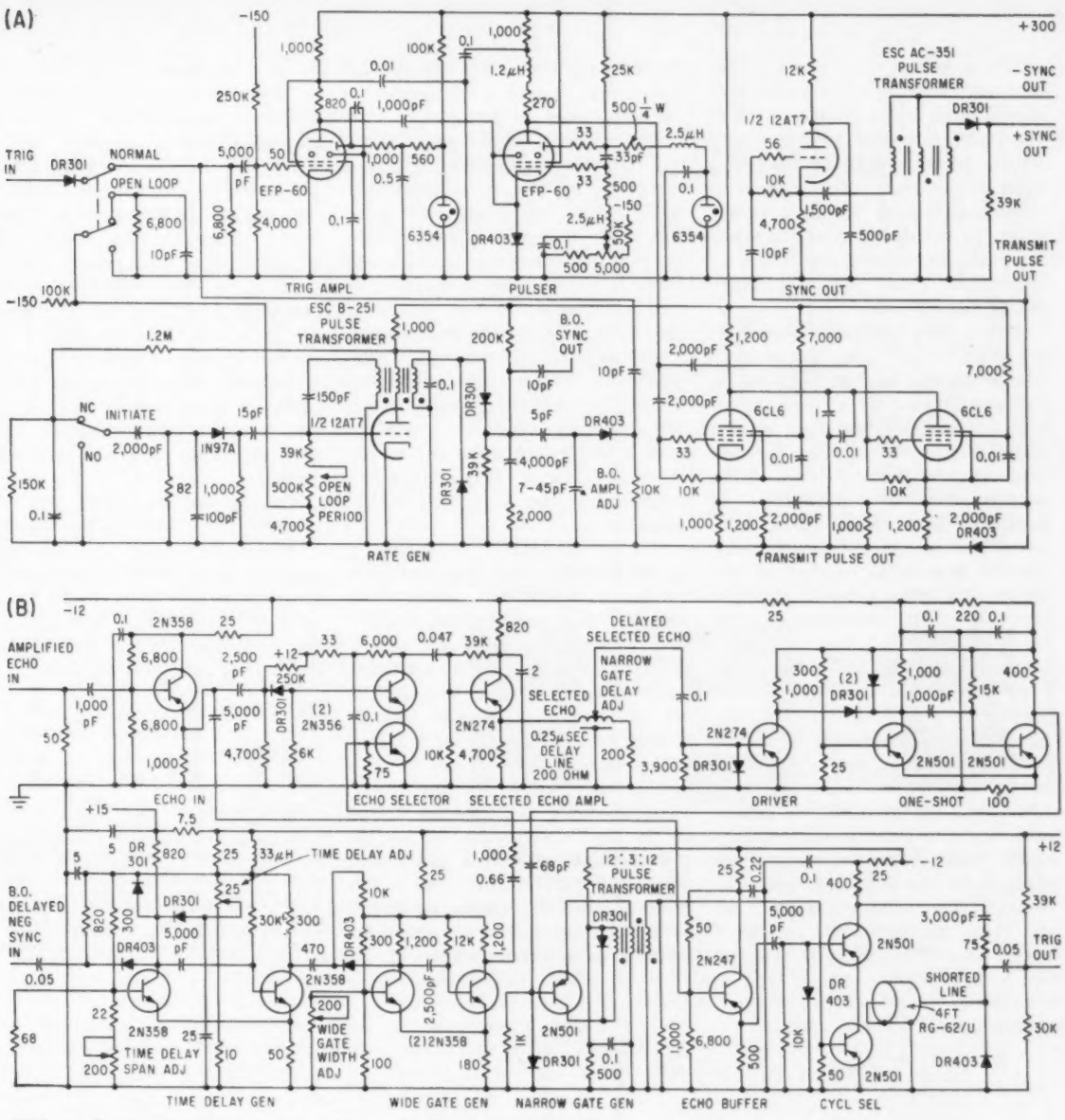

FIG. 2—Schematics of transmitter (A) and trigger generator (B)

line before triggering the time-delay generator in the trigger generator. The delay line minimizes recovery-time requirements of the monostable multivibrator time-delay generator. A monostable multivibrator wide-gate generator is triggered by the trailing edge of the pulse from the time-delay generator, to produce the echo-selecting, wide-gate pulse. The echoes are detected before entering the echo selector circuit, which is a series transistor coincidence circuit. The selected echo is delayed in a 0 to 0.25 μsec variable delay line before triggering the narrow gate generator. The variable delay is adjusted to permit the narrow gate to bracket a selected cycle in the selected echo. A one-shot multivibrator precedes the blocking oscillator narrow-gate generator to prevent multiple firing during the relatively long rise time of the selected echo. The 0.1-μsec narrow gate pulse is then combined with the undetected echo in a fast, series transistor coincidence circuit to obtain the trigger output pulse which retriggers the transmitter.

The timing system and illustrative waveforms are shown in Fig. 3A. A modified comercial counter counts out a preset number n of sing-around cycles, where n can equal 10^3, 10^4, 10^5 or 10^6. A timer, using an internal 10-Mc crystal-controlled oscillator as a reference, measures the time elapsing during the n sing-around cycles.

The auxiliary circuitry shown minimizes readout variations. All sync inputs occur simultaneously with transmit pulse generation that initiates each sing-around cycle. Assume that readout of both counter and timer has just concluded with the timer automatically

resetting last. A timing interval begins only when coincidence between a sync pulse and a negative peak of the 10-Mc reference occurs, usually within 10 or 20 sing-around cycles after timer reset. This procedure eliminates nearly 0.1 μsec uncertainty in the duration of the timed interval. The start-pulse generator starts the timer which in turn starts the counter.

Although it is possible to permit a pulse from the appropriate counter decade to stop the timer at the conclusion of n sing-around cycles, a variable period of several microseconds is required for the cumulative triggering delay of the counter decades. Instead it is arranged that the $(n-1)$th sync pulse will open a gate, permitting the nth sync pulse to shut off the timer. An extra pulse is injected into the counter immediately after the beginning of the measured interval, causing the counter to read one more than the actual number of sing-around cycles during the counting period. Thus the counter indication reaches n when the $(n-1)$th sync pulse arrives, whereupon the stop gate is generated and the counter immediately stops itself; the timer is then stopped by the nth sync pulse as desired. The total uncertainty in the time measurement is about ±0.06 μsec. Thus if n is selected to make the timed interval at least 0.6 second, 1 part in 10^7 resolution or better may be attained.

The counter control unit, which incorporates the auxiliary counting circuitry, is shown schematically in Fig. 3B. The timer start-pulse generator is again a fast, series transistor coincidence circuit, which insures that the measured interval will begin within 10 nsec of a negative peak of the reference signal. The stop-gate generator is a one-shot multivibrator that keeps the series 1N97A diode from passing the blocking oscillator negative sync pulse, except when the multivibrator is fired. The extra pulse generator is also a one-shot multivibrator.

The system stability is indicated by the fact that during a 12-minute check on a silver single-crystal sample, with longitudinal waves, and readout occurring at seven-second intervals, timer readings were constant within 5 parts in 10^6 for over four minutes, within 1 part in 10^7 for over 10 minutes and within 2 parts in 10^7 for the entire run. Part of the instability is attributable to frequency drifts in the 10-Mc reference, quoted as 3 parts in 10^7 per week and measured as 5 parts in 10^8 over a 10-minute interval. Sample temperature drifts are also of significance: 0.001 F sample temperature drift results in approximately one part in 10^7 velocity change in silver at ambient temperature. Environmentally-induced readout variations due to velocity changes may be partially masked by readout changes due to simultaneous ultrasonic attenuation changes. The minimum detectable velocity change depends on the magnitude of the accompanying attenuation change and how accurately one knows the amount of phase shift introduced when electronic attenuation variations are made to compensate for a change in ultrasonic attenuation, to give the same electrical echo amplitude.

The system has been used to measure the change in the velocity of longitudinal waves in vanadium when going from the normal to the superconducting state at 4.2 K. A velocity change of 5 parts in 10^6 was measured[5] with a reproducibility better than 10 percent.

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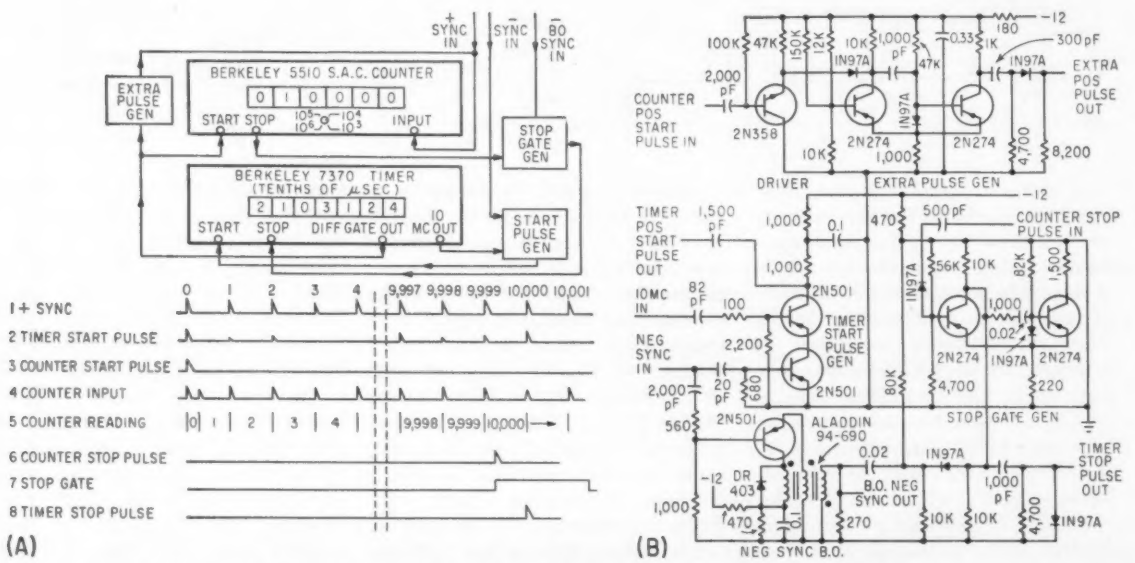

FIG. 3—Timing system and illustrative waveforms (A) and schematic of counter control unit (B)

OSCILLOSCOPE BAR CHART

Monitors Sixty Channels

Missile operation data is plotted in bar-graph form on 17-inch cathode-ray tube

By E. R. JABLONSKI,
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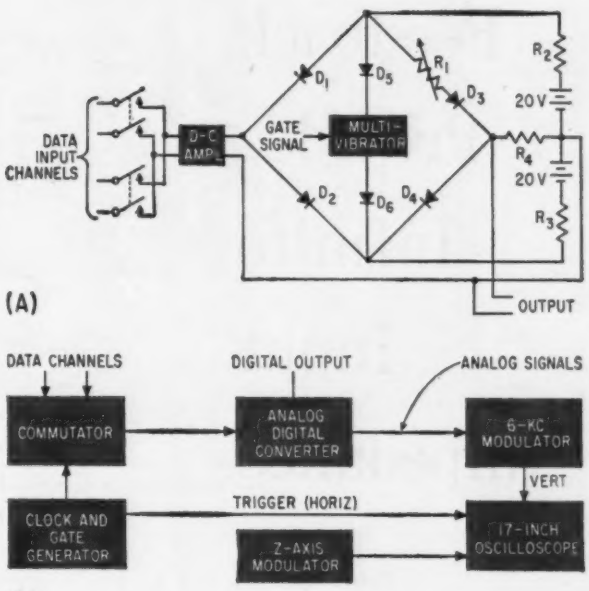


Diode biasing controls signal gate (A). All three axes of oscilloscope are used (B)

BAR-GRAPH PRESENTATION on a 17-inch oscilloscope permits continuous visual monitoring of 60 different analog signals simultaneously. The signals, each representing a data channel, are fed sequentially to the vertical input of the oscilloscope. A synchronizing step voltage is fed to the horizontal input to locate the bar for each channel in a fixed position on the screen.

This bar-graph oscilloscope is used at the control console of a new mobile data processing system recently delivered to the Army Ballistic Missile Agency and used with the Saturn and Jupiter missile projects. The system accepts analog information from the missile, and processes and records it on magnetic tape for transmission to an IBM 704 computer.

Up to 215 channels of low-level analog data from transducers can be fed into the data-processing system. The signals are conditioned to make them compatible and are routed and combined. Facilities are provided for recording and metering the input channels prior to conversion to digital form.

An electromechanical/electronic commutator samples 60 conditioned analog data channels at 600 samples a second. One of the 60 channels carries timing information. Each channel is sampled 10 times a second by sequentially energized high-speed relays.

Each bank of 12 relays feeds a d-c amplifier that is followed by a semiconductor switch. The relays are wired so that each of the five d-c amplifier/semiconductor switch chains sees every fifth data channel. Thus, each looks at 12 different signals, 10 times a second. The resulting five output signals, occurring at 120 pps, are paralleled to form a train of 600 pulses a second.

Two of the 12 sampling relays associated with one d-c amplifier/semiconductor switch chain are shown in A. When either relay is closed, the proper signal is fed to the d-c amplifier. The amplified signal is fed to the semiconductor switch, shown in simplified form. The signal cannot get through to load resistor R_1 when the diodes D_1, D_2, D_3 and D_4 are biased to oppose an input signal.

The multivibrator, when triggered by a channel gate signal, applies opposing voltages through D_5 and D_6. This permits the signal to reach R_1. The relays are energized for several channel gate times, allowing the contacts to reach a stable closed position. Then the semiconductor switch, keyed for a much shorter time, allows the signal sample to get through.

As shown in B, the commutated signals are fed to the analog-to-digital converter that sends on powered analog signal samples of the same amplitude as the ones received. These signals are filled in by the 6-kc modulator and fed to the vertical scope input. Another modulator feeds a signal to the Z-axis input of the scope. By varying the amplitude of this signal, the brilliance of the illuminated bar may be adjusted. Individual Z-axis signal controls and switches enable dimming or blanking any of the 60 vertical bars.

A Federal 1735-D oscilloscope with a rectangular, medium-persistence 17-inch crt was used.

Positive Feedback Provides Infinite Input Impedance

Properties of two-amplifier black box find applications in analog computing

By EMANUEL KATELL,
Senior Project Engineer,
Reeves Instrument Corp.,
Garden City, N. Y.

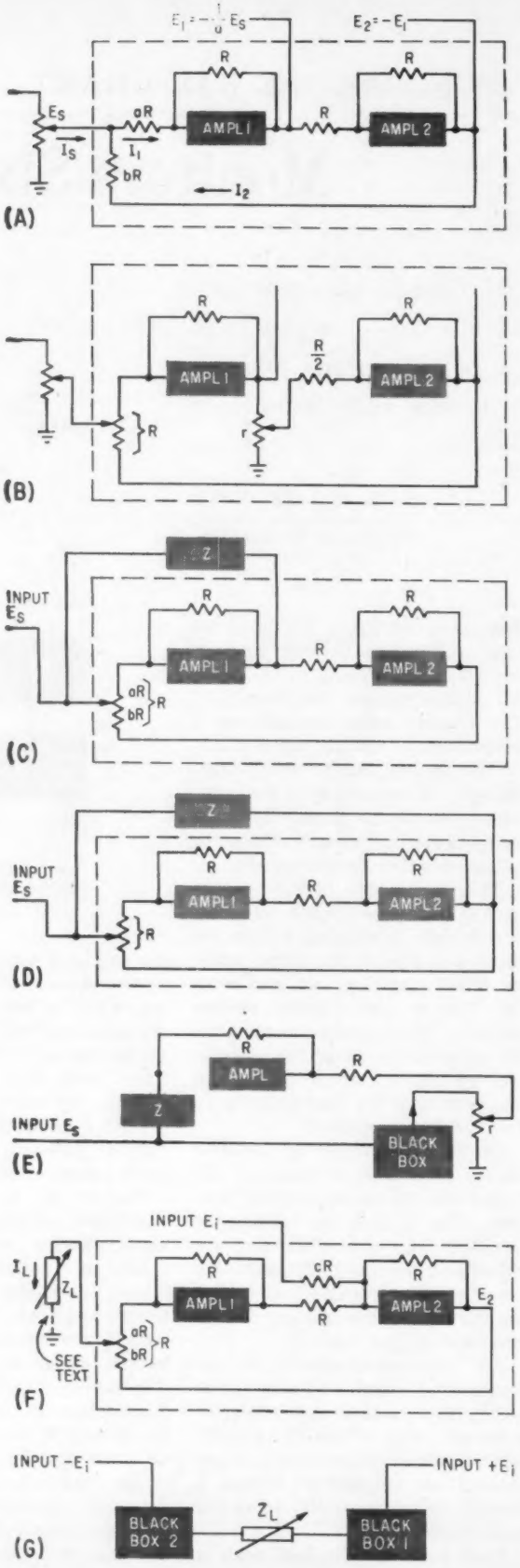
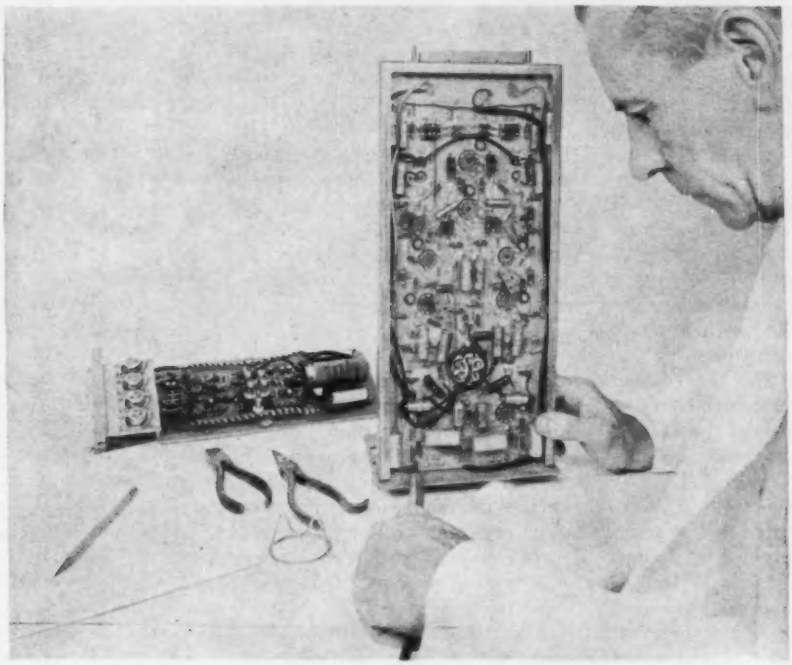


FIG 1—Criterion of infinite impedance is met if loop gain is unity (A). Connection for trimming gain is shown in (B); (C) shows unity gain loop connected as impedance divider, $k > 0$; and (D) connected as impedance divider, $k < 0$. Use of variable-gain output amplifier (E); (F) black box precision current source; (G) two-box floating current source



Photograph illustrates work on a d-c operational amplifier. The same amplifier, in a fully transistorized version, is shown in the background

POSITIVE-FEEDBACK LOOPS with a gain of unity can be useful as infinite-impedance unloading circuits, for precision voltage-source to current-source conversion, and for the division of impedances. Figure 1A shows an unloading loop with infinite input impedance. Analysis of this loop illustrates basic principles that apply to the other configurations as well.

Summing currents at the input, $I_s = I_1 - I_2$. By inspection of Fig. 1A, since the summing junction is at zero potential, $I_1 = E_s/aR$ and $I_2 = (E_2 - E_s)/bR$. However, $E_2 = E_s/a$; thus $I_s = (E_s/R)\ (1/a - 1/ab + 1/b) = (E_s/R)\ [(a + b - 1)/ab]$.

If $a + b = 1$, then $I_s = 0$ and E_s sees an infinite impedance. Thus the current I_s supplied by E_s into the black box will be zero when $a + b = 1$, that is if the loop gain is unity when the load (in this case the signal source) is disconnected. It would appear from this that the combinations of a and b are virtually unlimited, but such is not the case. If amplifiers 1 and 2 are d-c amplifiers such as are used in analog computers, only a finite output voltage V_o is available. If a gain considerably greater than 1 is chosen for one of the amplifiers, a voltage swing greater than V_o may be demanded, and this would cause the amplifier to overload.

Stability is another important consideration for the black box in Fig. 1. A positive-feedback loop with a gain of unity and a phase of zero will be unstable. Thus, if the signal potentiometer is disconnected, the loop will saturate. If, however, the signal potentiometer is left connected to the input terminal (whether excited by a signal voltage or not) it will lower the loop gain and stabilize the loop.

Figure 1B shows one way in which the loop can be set up. Potentiometer r together with the input resistor to amplifier 2 permits the loop to be accurately trimmed to unity gain. If the loop gain is too high, the potentiometer is set below its center; if too low, the potentiometer is set above its center.

The infinite impedance loop can be used to read or transmit the voltage stored in a capacitor without discharging it. If a capacitor charged to E_s is connected to the input terminal, the voltage E_s/a can be read at the output of amplifier 2. An application would be measuring of long-term leakage on polystyrene capacitors.

The black box will have infinite input impedance if $a + b = 1$. Thus $aR + bR = R$. In Fig. 1B the resistors aR and bR have been replaced by a precision resistance divider box whose total resistance is R. Regardless of where the slider is placed, the condition for infinite input impedance is met.

The voltage at the output of amplifier 1 will be $E_1 = -(E_s/a)$ and correspondingly, the voltage at the output of amplifier 2 will be $E_2 = -E_1 = +(E_s/a)$, where $1/a$ may be varied from unity to a value approaching the open loop gain of the amplifier. Since these are operational amplifiers, their output impedances may be considered to be zero.

The black box, therefore, has infinite input impedance, zero output

impedance and variable gain. With idealized computing amplifiers, gain can be varied from minus infinity to plus infinity depending on which amplifier is chosen as the output amplifier. These properties give the black box a universality of applications beyond those already suggested.

One application of the black box is in impedance division. Figure 2A shows an impedance Z_0 driven by a source voltage E_s and drawing a current I_{so}. If the impedance is lifted off ground and returned to a low impedance generator $-kE_s$ as shown in Figure 2B, the current drawn from the source will be modified to $(1 + k)\ I_{so}$ and the equivalent impedance Z_E seen by the source will be $Z_E = E_s/[(1 + k)\ I_{so}] = Z_0/(1 + k)$.

If k is greater than 0, the original impedance is divided by a number greater than 1 and the impedance seen by the source is lowered. If k is less than 0 the original impedance is divided by a number less than 1 and the impedance seen by the source is increased. When k takes on negative values with magnitude greater than 1 a negative impedance is obtained. The circuit is thus useful as a Q multiplier.

Figure 2C shows the circuit elements connected to the generalized black box. Since the box has an infinite input impedance it may be connected to the upper terminal of the impedance Z_0 without disturbing the current through it. With this connection it is possible to obtain a precise value of $-kE_s$. When the lower terminal of the impedance is connected to the output of the first amplifier in Fig. 1C, impedance division results.

By nature of the circuit, quantity k must have a magnitude greater than one. To obtain $|k| \leq 1$, it is necessary to use an output amplifier with adjustable gain. This amplifier is shown in Fig. 1E connected to the black box. It is connected to the output of the first or the second amplifier in the box, depending on whether a decrease or an increase of impedance is desired.

When resistors aR and bR are replaced by a precision resistance divider box as indicated in Fig. 1C, it is possible to obtain precise, continuous division of the impedance Z over a broad range. With input voltage level chosen to prevent the amplifiers from overloading, a division range of 100 to 1 is feasible. This is useful in obtaining large apparent values of capacitance for thermoelectric models.

When k is negative (Fig. 1D), the impedance Z_E is in parallel with one of the resistors that determine the loop gain. The net effect will be to make the loop gain greater than unity. For stability, therefore, the impedance of the source should be low enough to bring the gain below unity.

In Fig. 1F the loop is modified to obtain a black box precision current source. Major advantage of this application is that load, Z_L, may be connected to ground or to an arbitrary voltage. A second advantage of the two-amplifier loop as a precision voltage-to-current source converter is that no approximations need be made; the current is exactly proportional to E_1. Thus it is possible to obtain precise control of the current in a gyro Microsyn from a voltage source.

Load impedance Z_L sees an infinite-impedance source. The current through the load impedance is independent of Z_L, and may be calculated by assuming $Z_L = 0$. Then $E_1 = 0$, $E_2 = -(E_i/c)$ and the current in the load is simply E_2/bR. Since the source impedance is infinite, even if Z_L is not zero the current in the load is $I_L = (E_i/bcR)$. If the input voltage E_i is introduced at amplifier 1 instead of amplifier 2, then $I_L = +E_i/bcR$. The loop gain, neglecting the load resistor, is unity. This will be satisfied by $a + b = 1$.

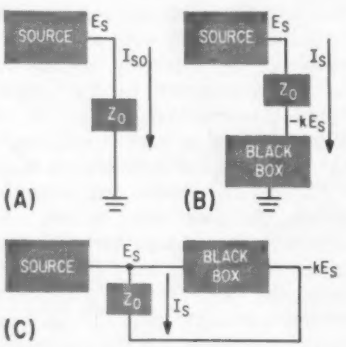


FIG. 2—Original impedance is shown in (A); impedance is modified by adding generator (B); functional representation of impedance divider or multiplier (C)

A floating precision current source can be obtained by two such circuits. (See Fig. 1G). If the circuit constants a, b, and c are chosen to be equal for both black boxes, the current will be $I_L = E_i/bcR$.

An analysis of the precision current configuration illustrates the instability of the unity gain loop when the signal source impedance is disconnected. In Fig. 1F the current I_L in the load impedance will remain constant as Z_L is increased. The voltage at the junction of resistors aR and bR will increase accordingly, since it is equal to I_L/Z_L. As Z_L is increased towards large values (open circuit), a voltage I_LZ_L will be reached where the voltage demanded out of amplifier 2 will exceed the maximum voltage the amplifier can supply.

The smaller I_L, the larger the permissible value of Z_L; but even if I_L is close to zero, Z_L must still be less than infinite.

Thus, if the unity gain loop is not loaded by a finite impedance, the amplifiers will saturate.

The infinite input impedance circuit in its various forms has particular application as a laboratory tool.

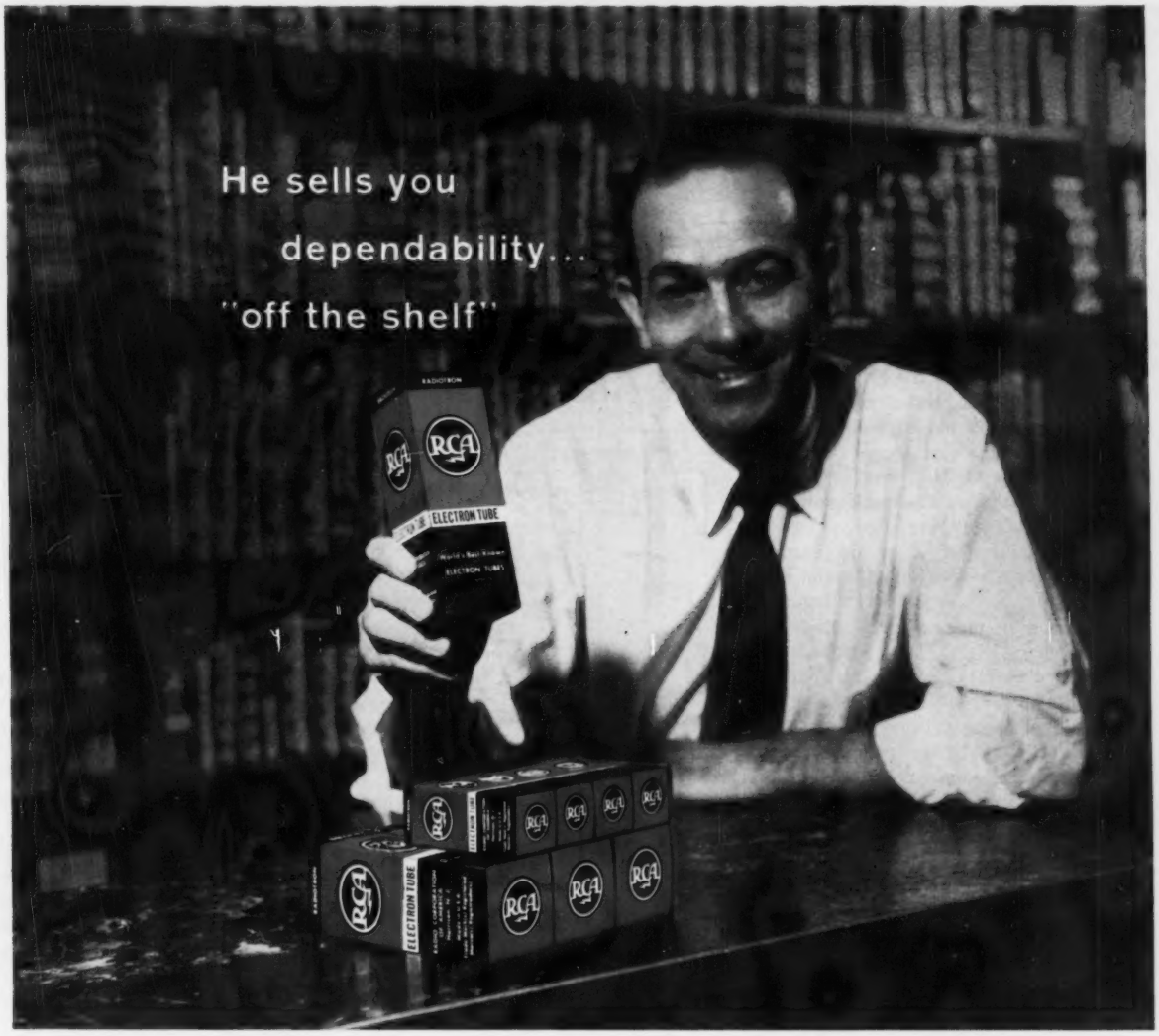
The following are typical:

In analyzing thermo-electric models of a missile, large values of capacitance are required. With the impedance divider circuit odd values of capacitance in the several hundred microfarad range can be obtained to accuracies of 1 percent.

Using the basic unloading circuit, it is possible to measure long-term leakage on polystyrene capacitors without loading by the measuring circuit. This same circuit also acts as a power-gain stage.

Precise control of the current in a gyro Microsyn by means of a voltage source is made possible by the precision current connection; at the same time it becomes possible to ground one end of the Microsyn, a facility which typical constant-current sources do not provide.

While the black box discussed has been analyzed with d-c operational amplifiers, it may also be instrumented with a-c feedback amplifiers, tube or transistorized. The black box thus provides the feasibility of infinite input impedance transistor amplifiers, eliminating the need for transformer coupling into the input stage.



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Duplicating Transmitted Binary Signals

By D. H. BRYAN, Hawthorne, Calif.

BINARY encoded signals that have experienced filtering effects in transmission can be reproduced so that a fixed time relationship is maintained with the original transmitted pulses. Exact reforming of the pulses is made possible by incorporating a clock generator at the receiving end. Its frequency is kept equal to that of the clock generator at the transmitting site.

Transmission of binary encoded information over narrow-band lines or radio links causes significant increases in rise and fall times, as shown in Fig. 1. To reproduce the square waves transmitted, a Schmitt trigger controlled by the received signal had been used. However, because of the filtering effects, the leading and trailing edges of output from the Schmitt circuit did not have a fixed time relationship with those of the transmitted pulses, as shown in the figure.

This difficulty was overcome with the circuit shown in the block diagram in Fig. 2. The blocking oscillator provides clock pulses to the flip flop. Output pulses from the Schmitt circuit are also sampled by the flip flop so that its state is dependent on both clock and Schmitt trigger output. If changes in Schmitt trigger output do not occur on an average at the time that a clock pulse is generated, repetition frequency of the blocking oscillator is changed accordingly.

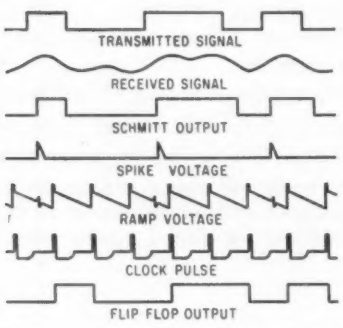

FIG. 1—Waveforms show ramp voltage sampled to reproduce transmitted signal

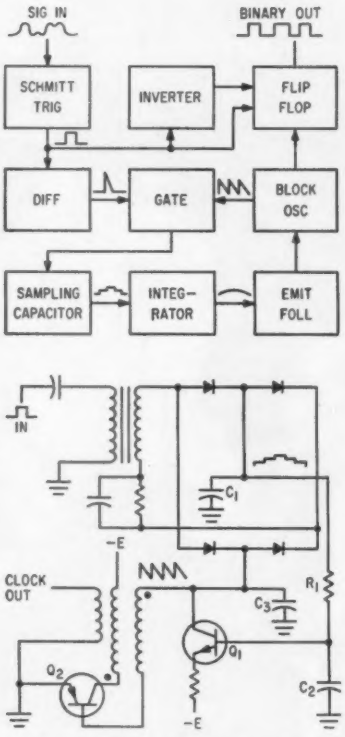

FIG. 2—Block diagram and simplified schematic show clock control circuit providing timing pulses

To control oscillator frequency, output from the Schmitt trigger is differentiated. The resulting spike is applied to the diode gate in the simplified schematic in Fig. 2. When the blocking oscillator fires, a reasonably linear ramp voltage is produced. Amplitude of this voltage is sampled by sampling capacitor C_1 when the spike is applied to the gate. If clock frequency is correct, voltage across C_1 remains constant. If it is not, voltage across C_1 changes in steps.

The stepped voltage is integrated by R_1 and C_2, and the slowly varying d-c voltage is applied to the base of emitter follower Q_1. Firing of this blocking oscillator charges capacitor C_2, which is discharged through Q_1 at a reasonably linear rate determined by the voltage applied to the transistor base. Repetition frequency of the blocking oscillator is controlled by the integrated stepped voltage applied to the base of Q_1. Thus clock frequency at the receiving end is changed if oscillator frequency drifts or if clock generator frequency at the transmitting end changes, controlling signal time relationship.

Microwave Attenuation Test Methods Compared

COMPARISONS of two methods for measuring microwave attenuation were made using a technique that virtually eliminates environmental influences.[1] Both measuring techniques were developed at the National Bureau of Standards, which also made the comparisons at the Radio Standards Laboratory, Boulder, Colo.

A high-precision system for measuring power attenuation[2, 3] was used as a reference to test a recently developed subcarrier technique.[4] The two methods, both significantly more precise than others now in use, agree within 10 microbels.

Two-channel waveguide systems are used in each measuring system. By using directional couplers, the limited power required for the subcarrier techniques can be obtained from the power measuring system without disturbing it. The test attenuator can therefore be placed in a single channel common to both systems. Environmental effects and mismatch errors are eliminated, and limits in resetting the attenuator are minimized when making comparisons.

A rotary-vane type waveguide variable attenuator was used for the comparisons, which were made at 9.4 Gc. Precision of the modulated subcarrier method was about 0.0005 db at low values of relative attenuation but decreased to about 0.005 db at 20-db relative attenuation.

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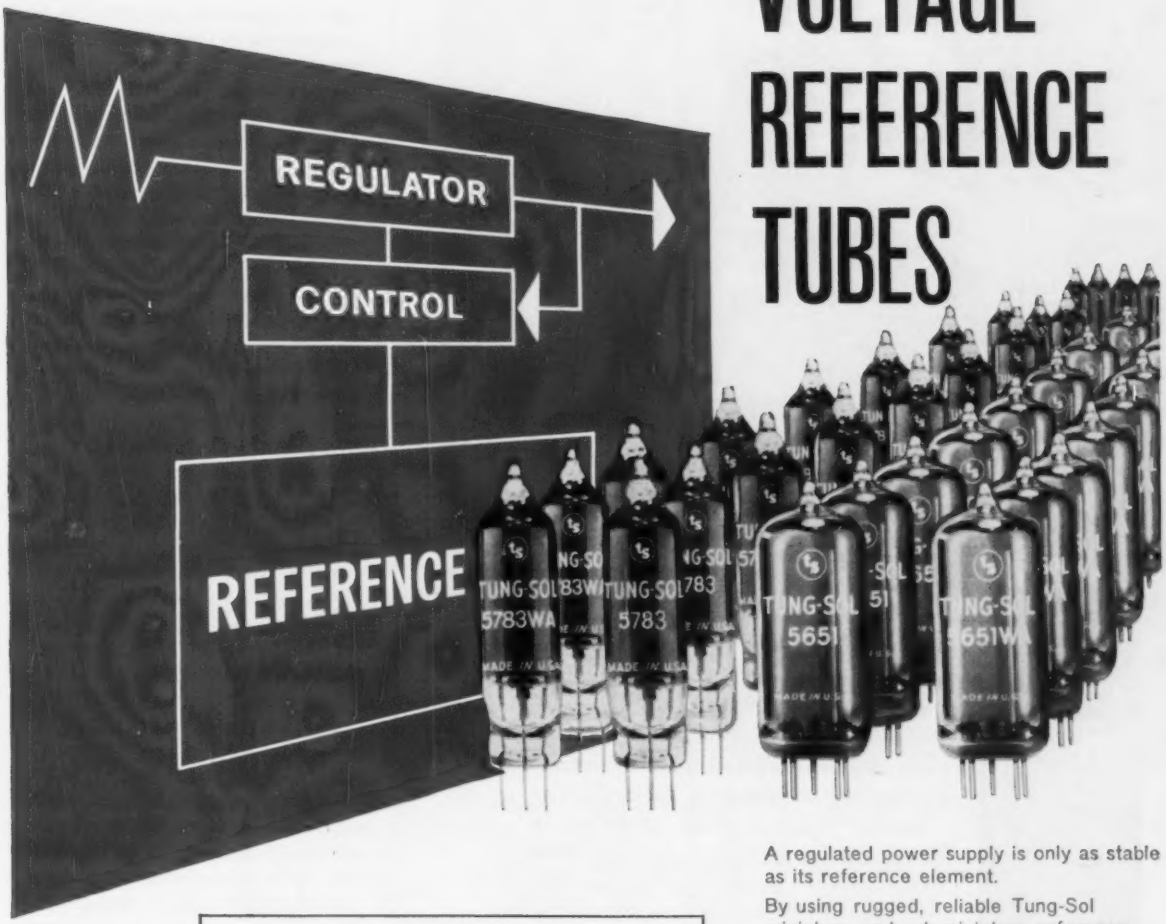

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Reliable stability for regulated power supplies

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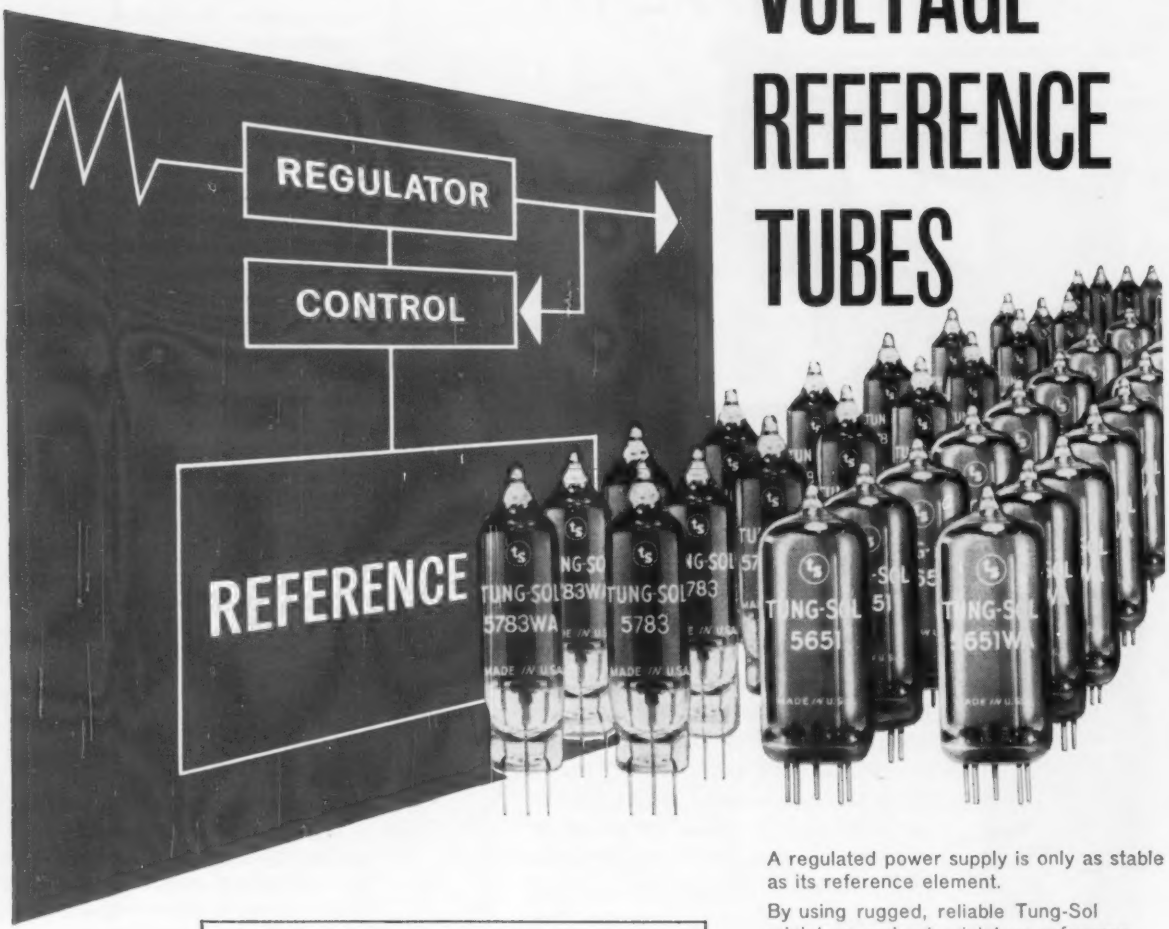

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Recording Changes in Earth's Magnetic Field

VARIATIONS in the earth's magnetic field will be recorded in a series of experiments this fall. The tests are intended to determine extras terrestrial influences causing these disturbances and to indicate methods of circumventing their effects on communications.

Sponsored by the Office of Naval Research, the tests will be carried out on Santa Maria Island in the Azores by Stromberg-Carlson Division of General Dynamics.

Ten special loop antennas have been fabricated for the project. Each 4-foot diameter loop contains 5,000 turns of copper wire. The loops will be aligned and bolted between two plywood face plates using brass bolts to avoid the presence of magnetic materials. In making measurements, the loops will be mounted vertically in a north-south plane, then rotated to an east-west plane, and finally positioned horizontally.

Ideally, measurements should be made on a fixed non-magnetic platform in the middle of the ocean. A shipboard installation would not maintain the needed motionless condition for the antennas. In addition to offering physical stability, Santa Maria Island is located at the correct latitude and has no large electric generating plants or distribution lines that might create local magnetic disturbances. Power will be provided by a portable generator about ½ mile from the test site and will be carried to the measuring equipment by shielded cables.

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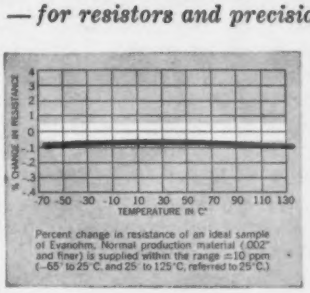

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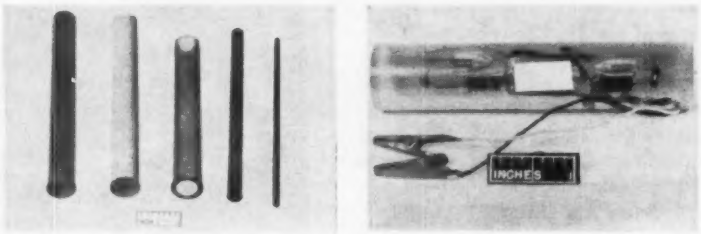
CIRCLE 109 ON READER SERVICE CARD 109

Encapsulating Components Using Epoxy Tubing

By M. J. BODNAR
R. F. WEGMAN
Materials Research Section,
Picatinny Arsenal, Dover, N. J.



Epoxy tubing of various diameters and wall thicknesses (left). Component encapsulated in an epoxy tubing with an epoxy resin (right)

THE USE OF TUBING as a mold in the encapsulation of small electronic components obviates the need for jigs and removable molds, makes possible a lower exotherm, and eliminates the thermal coefficient problem encountered with metal case-molds.

The high-frequency vibrations encountered in missiles and rockets often cause electronic equipment to fail as a result of loosening of the wires from terminals, or fracture of fragile components. One technique frequently used to overcome this problem is to encapsulate the parts in a resin. Small parts of an electronic device can be encapsulated as plug-in type subassemblies, each mounted independently. Such encapsulation minimizes vibration effects and simplifies replacement of defective parts.

A method commonly used to encapsulate electronic parts includes the use of a metallic mold precoated with a mold-release agent. The parts to be encapsulated are placed into the mold and the resin is cast. When the resin is cured, the mold is disassembled and removed. If it is necessary to encapsulate components into a case, a metal is often selected as the case material. Preformed plastic case-molds would be preferable, however, since the properties of the mold and the casting resin can be kept essentially the same by using the same type resin for each. For example, a polyester case could be used with a polyester encapsulating compound. This is especially significant in that the thermal coefficients of expansion of the mold and resin are the same.

If a metal case or mold is used, a high stress occurs at the metal-case resin interface when the item is subjected to low temperatures. The bond at this interface is then very sensitive to mechanical shock and vibrations. Use of the plastic mold eliminates this aspect of the thermal coefficient problem.

Often the encapsulating resin is an epoxy-based material. Epoxies used in encapsulation of electronic components have good mechanical properties, adhere well to most components being encapsulated, and have good electrical properties (such as high volume resistivity). Another advantage: they are not drastically affected by the temperatures and humidities usually encountered by Ordnance items.

Epoxy resins are now being used in the fabrication of tubing which can be used as molds. This tubing, which is available commercially, comes in various dimensions, as seen in photo. By choosing a tube with the desired outside measurements and a wall thickness such as to allow the insertion of an electronic component, encapsulated units can be manufactured without the use of removable molds and complicated jigging devices. Furthermore, by using a thick-walled epoxy tube, the volume of the encapsulated assembly can be increased without the development of as high an exotherm as might be encountered using a larger volume of liquid casting resin.

The higher exotherm is especially undesirable in the encapsulation of miniature power sources such as batteries. These power sources can be weakened by excessive heat while the resin is in a liquid and therefore more conductive state than the cured solid resin. The low exotherm minimizes the drain of the charge from the batteries.

The procedure for encapsulating electronic components with epoxy tubing molds includes:

Selecting the proper size tubing which will encase the components and give the desired outside diameter; cutting the tubing longer than necessary so that it can be used as a container for the liquid epoxy resin after one end of it is plugged; inserting the electronic component into the tube; filling the tube with potting resin; curing the potting resin; and cutting the ends.

A component encapsulated by this procedure, (photo above) consists of a capacitor, two resistors, and two neon bulbs. The lead wires were brought out through two small holes which had been drilled into the side of the tubing. The casting resin used was a bisphenol A based epoxy cured with an adduct of diethylene triamine.

Typical electrical properties of this resin when cured are: volume resistivity at 130 C, 10^{10} ohm-cm; and dielectric strength, short time, >400 volts/mil.

To determine whether or not the encapsulated component would function properly after storage at high humidities it was decided to subject the assembly to a relative humidity of 95 percent at 100 F (38 C) for 7 days. It was feared that the contraction of the epoxy encapsulating compound away from the inner wall during cure of the resin might create minute voids or

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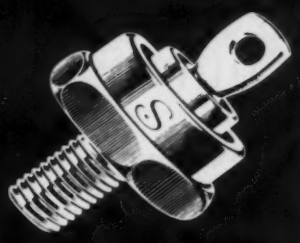

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620 East Dyer Road, Santa Ana, California - Kimberly 5-8241

In August, the Standard Rectifier Corporation launched its national advertising campaign. The original ad of this new series is shown reproduced above. The response it has enjoyed, since initially appearing in the electronic trade journals, has been tremendous! It has resulted in literally hundreds of requests for further information.

The Standard Rectifier Corporation is fully aware of the need... indeed the demand of industry for electronic components that embody greater factors of *safety* and *reliability*. To further substantiate those claims made in reference to the quality of our products, we have listed below a few of the more important reasons why an ever-increasing number of engineers are specifying SRC!

1 SRC uses an aluminum-silicon junction substantially larger in area than industry standards. SRC's "planer" type construction extends the area of contact across the entire silicon chip.
BENEFIT: Nearly twice the one-surge rating of competitive products! More efficient heat dissipation... longer life.

2 Every SRC rectifier product is completely production tested and inspected by the use of oscilloscope sweeping techniques at 100 volts above, or two times rated PIV, whichever is smaller.
BENEFIT: Far greater transient protection.

3 Another plus feature of SRC's unique type of construction is its newly-developed method of utilizing nickel coated molybdenum discs in their "floating" contact design... this results in a nearly perfect bonding of materials.
BENEFIT: Less thermal fatigue aging.

4 SRC extensively tests its rectifiers for current surge ratings. Example: The 35 amp series is tested at 350 amps for two seconds. Independent lab tests show it will safely handle eight milli-second pulses up to 1200 amperes!*
BENEFIT: Better overload and surge protection, thus resulting in more effective fuse protection.

In the coming months our ads will serve to introduce many new and exciting products... the results of Standard's research and development. We hope you will watch for them, and we invite your inquiries.

**As substantiated by the United Testing Laboratories*

STANDARD OF QUALITY

STANDARD RECTIFIER CORP.

620 East Dyer Road, Santa Ana, California

Kimberly 5-8241—TWX: S ANA 8103

44 44 44 44

the number to remember

44 44 44 44

for faster soldering!

KESTER "44"

RESIN-CORE SOLDER

You get the fastest possible soldering action with Kester "44" Resin-Core Solder, created for today's high speed requirements. "44" Resin meets all applicable MIL and Federal specifications, latest amendments, Army, Navy, Air Force. Flux-residue non-corrosive and non-conductive. All alloys, cores and diameters . . . on 1 lb., 5 lb. and 20 lb. spools.

FREE. WRITE for 78-page Technical Manual "SOLDER . . . Its Fundamentals and Usage."

Kester Solder

COMPANY

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Newark 5, New Jersey • Anaheim, California • Brantford, Ontario, Canada

Over 61 Years' Experience in Solder and Flux Manufacturing

112 CIRCLE 112 ON READER SERVICE CARD

leakage paths for moisture. A tight fitting electronic component might further increase the possibility of such voids or leakage paths. These paths would cause the item to have inferior electrical insulation. Upon completion of the temperature-humidity environmental storage test, however, the encapsulated assembly was tested for functionability and performed satisfactorily.

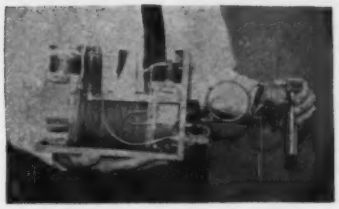
On the basis of the limited study conducted it appears that epoxy molds having other configurations can be used in encapsulation as long as total volume shrinkage of the resin during cure is minimized. A high total volume shrinkage would result in high internal stresses in the mold. It may be desirable to precast an epoxy mold of the shape required in a plastisol mold. The electronic component can then be embedded into a cavity in the mold itself. The cavity can be premolded to the desired shape and dimensions. In simple applications a cavity can be drilled or machined out by other methods. It is also possible that epoxy inserts can be used to further reduce exotherm during cure.

Self-Sustaining Unit Cools Components to 80 K

FOR SEVERAL YEARS, Air Products Inc., of Allentown, Pa. has conducted extensive development programs on cryogenic equipment for electronic applications. Work has been carried out on all basic cooling systems, including open and closed, single and multi-fluid, Joule-Thomson and expansion engine designs.

The cryogenic electronics industry is now using several of these systems, built by both Air Products and other manufacturers, mainly of the non-self-sustaining type. The systems are quite reliable but require a supply of gaseous or liquid nitrogen, hydrogen or helium. These systems have proved quite satisfactory for test applications, but there has been a need for self-sustaining systems for actual applications, such as airborne use, where no liquid or gas is available.

The system now offered on a commercial basis is a self-sustaining cryogenic unit with miniaturized components. This system is a closed-



Self-sustaining cryogenic unit

cycle nitrogen refrigerator capable of cooling a component down to 80 K (−316 F) with a capacity of one watt of refrigeration.

The essential components of this system are: a non-lubricated, two-stage, piston-type compressor and motor all hermetically sealed; an adsorber filter; and a heat exchanger.

The entire system weighs only 16 pounds and can be easily held in the hand (see illustration). The compressor unit is connected to the refrigeration element by flexible lines which may separate the two by any distance within practical limits.

This particular system uses nitrogen, but argon could be substituted for greater refrigeration and quicker cool down. The heat exchanger is a coiled finned tubing mounted in a dewar. The crystal to be cooled is located at the base of the dewar where liquefied nitrogen provides a "cold spot."

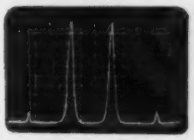
The two-stage compressor delivers nitrogen at about 1,000 psig through the adsorber-filter to the heat exchanger. The high-pressure gas enters coiled finned tubing in which it is cooled in counter-current heat exchange with returning cold, low pressure gas. The cooled high-pressure gas is discharged into the shell side of the exchanger where part is liquefied. The liquid provides cooling for the particular electronic component. The low pressure gas is then returned to the suction side of the compressor.

No gas or liquid supply is required. The system is designed to run continuously for 500 hours between maintenance periods. Both a 400 cycle, 208 volt, three-phase unit for airborne use and a 60 cycle, 115-v, single phase unit are available. The system operates in an ambient temperature range of −65 F to 125 F with a temperature control of ± 2 K; with a typical dewar, cool down time is 30 minutes.

now...analyze **both SSB & AM** transmitters & receivers faster with uniform sensitivity over entire **100 cps-40 mc** range

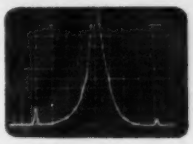
AT MINIMUM COST

Panoramic adds important NEW design features to the time-proven Model SSB-3! Now, in one convenient, compact package, you get the comprehensive unit you need to set up, adjust, monitor and trouble shoot SSB and AM transmitters *and* receivers.



TWO TONE TEST*

Fixed sweep width 2000 cps. Full scale log sideband tones 1.5 kc and 2.1 kc from carrier (not shown). Odd order I. M. distortion products down 37 db.



HUM TEST*

Indication of one sideband in above photo increased 20 db. Sweep width set to 150 cps reveals hum sidebands down 53 db and 60 db.

*See Panoramic Analyzer No. 3 describing testing techniques, etc., for single sidebands. A copy is yours for the asking.

GREATER FREQUENCY RANGE New Optional REC-1 Range Converter extends SSB-3a 2 mc-40 mc range down to 100 cps . . . speeds distortion analysis of receiver AF and IF outputs, transmitter bass band.

NEW 2-TONE AF GENERATOR MODEL TTG-2 2 generator frequencies, each selectable from 100 cps-10 kc • Resettable to 3 significant digits • Accuracy: ± 1% • Output Levels: each adjustable from 2 to 4 volts into matched 600 ohm load • Output DB Meter • Spurious, hum, etc., less than −60 db. • 100 db precision attenuation in 1 db steps.

FASTER-NEW TUNING HEAD FEATURES RAPID "SIGNAL SEARCH" PLUS PRECISE FINE TUNING.

ALL THESE NEW FEATURES . . . PLUS A SENSITIVE SPECTRUM ANALYZER

Panoramic's Model SB-12aS Panalyzor. Pre-set sweep widths of 150, 500, 2000, 10,000 and 30,000 cps with automatic optimum resolution for fast, easy operation. Continuously variable sweep width up to 100 kc for additional flexibility. 60 db dynamic range. 60 cps hum sidebands measurable to −60 db. High order sweep stability thru AFC network. Presisely calibrated lin & log amplitude scales. Standard 5" CRT with camera mount bezel. Two auxiliary outputs for chart recorder or large screen CRT.

INTERNAL CALIBRATING CIRCUITRY Two RF signal sources simulate two-tone test and check internal distortion and hum of analyzer. Center frequency marker with external AM provisions for sweep width calibrations.

the pioneer is the leader

dependable CERTIFIED SPECIFICATIONS for accurate data

Panoramic
RADIO PRODUCTS, INC.

Write, wire, phone RIGHT NOW for technical bulletin and prices on the new SSB-3a. Send for our new CATALOG DIGEST and ask to be put on our regular mailing list for The PANORAMIC ANALYZER featuring application data.

Sec. 2900

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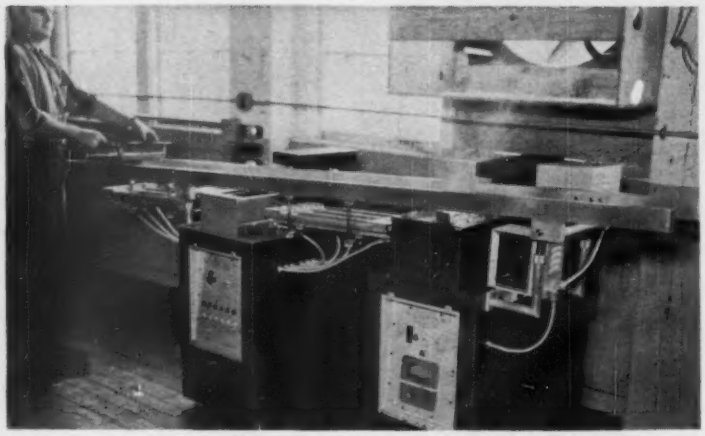
Phone: OWens 9-4600
TWX: MT-V-NY-5229
Cables: Panoramic, Mount Vernon N. Y. State

Mix Oil with Solder to Improve Wetting

WAVE SOLDERING machine which covers and mixes the molten solder with oil is reported to apply solder more uniformly and to reduce drossing. According to the manufacturer, Hollis Engineering, Inc., Weston, Mass., it can solder printed wiring boards with conductors spacings as close as 0.015 inch.

The oil floats on top of the molten solder in the pot, preventing dross formation there. The hot oil is sucked through a tube into the pump chamber, where it is mixed with the solder so that oil droplets are dispersed through the wave pumped out of the orifice.

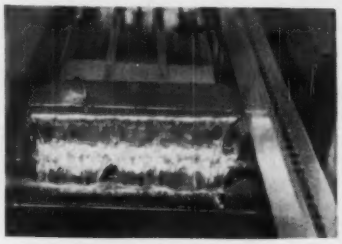
The droplets mist over the surface of the wave, again reducing oxidation and also lowering the solders' surface tension. The reduction of surface tension, Hollis says, improves the solder's wetting ability. This eliminates icicling and bridging, improves eyelet filling, makes the solder coating more uniform and reduces the amount of solder deposited. Shell terne oil No. 76 is recommended.



Conveyor links fluxing, infrared heating and soldering stations

The solder orifice can be set vertically, to produce a wave flowing evenly on both sides of the orifice, or it can be angled to produce a waterfall type of wave cascading in only one direction. The orifice plate is beveled to prevent corner interference when it is tilted.

Use of oil does not eliminate necessity of fluxing the boards. Wave fluxing station, infrared preheaters and additional conveyor lengths can be added to the soldering unit and its four-foot conveyor. Boards are carried in adjustable carriers. Conveyor speeds are adjustable to six feet a minute.



Closeup of solder wave and conveyor chain belt

Camera Tripods Become Fixtures

Standard camera tripod heads make a convenient holder for shafted subassemblies. The assembler can cock the head to the most convenient working angle. Sierra Electronics Corp., Menlo Park, Calif., mounts two dozen heads on a round of plywood to make a merry-go-round assembly fixture. The heads can also be used to mate subassemblies such as multipin connectors and rotary switches

Spring-Loaded Contacts Set in Block by Swaging

SPRING-LOADED, flat-head contacts, rather than pin-type connectors, are used to connect removable cartridge holders to record player tone arms made by Rek-O-Kut Co., Inc., Corona, N. Y. A swaging operation fastens the cartridge contacts in their block, sets the spring pressure and provides an expanded surface for lead soldering.

The assembler, inspecting parts

East

Marcus Hook, Pa.

West

El Segundo (Los Angeles), Calif.

in every major electronics center

B&A® assures fast, dependable supply of highest-purity "Electronic-Grade" chemicals

Wherever *your* electronics plant is located, you're close to a source of Baker & Adamson "Electronic-Grade" chemicals—the nation's highest-quality line. B&A production facilities at Chicago, Ill., El Segundo, Calif., Marcus Hook, Pa., and Nichols, California, plus 24 stock points across the nation assure *same or next day delivery* in most major electronics centers.

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B&A controls impurities in "Electronic-Grade" chemicals to a degree surpassing all previous standards! Highest purity is assured through rigorous methods of chemical and instrument analysis, and in the case of solvents is supplemented by resistivity measurements . . . a technique introduced by Baker & Adamson scientists to detect and determine trace impurities.

Our free booklet, "B&A Electronic Chemicals," includes a listing of products with specifications and uses. Write today, on company letterhead please, for your copy.

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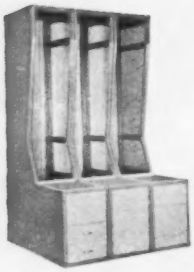
3-IN-ONE
AMCO ENCLOSURE SYSTEM

Provides Cooling, Mounting and Lighting in Modular Enclosures for Electronic Instruments in Any Installation



Aluminum

No one type of enclosure meets all environmental and physical demands. AMCO has developed 3 complete systems integrated into 1 system with interchangeable accessories, applicable for both commercial and military use.

CUSTOM . . . When space and appearance are critical . . . 16 ga. double-channel steel frames, based on increments of 19⅛" widths, supports in excess of 3000 lbs. Multi-width panels and cowlings give single-unit appearance with series mounted racks. Meets EIA Standards.

Semi-Custom

SEMI-CUSTOM . . . Heavy-duty, more internal clearance . . . 14 ga. box-channel steel frames, 12 ga. gusseting provides exceptional rigidity both front-to-back and side-to-side. Frames based on 22⅛" increments provides clearance for recessing 19" wide panels. Meets EIA Standards.

ALUMINUM . . . Unique! Meets any size . . . almost any configuration from 6 basic parts . . . 3 castings and 3 extrusions. Any size from 6" to 20 ft.; any slope from 0° to 90° is standard. Mil Specs strength and material (6061-T6 extrusions and 356-T6 castings).

Amco manufactures all necessary blowers, chassis slides, doors and drawers, writing surfaces, cowling lights and other accessories. **Check the extra savings you get thru Amco's combined-discount system of racks and accessories.** *PLUS FREE ASSEMBLY.*

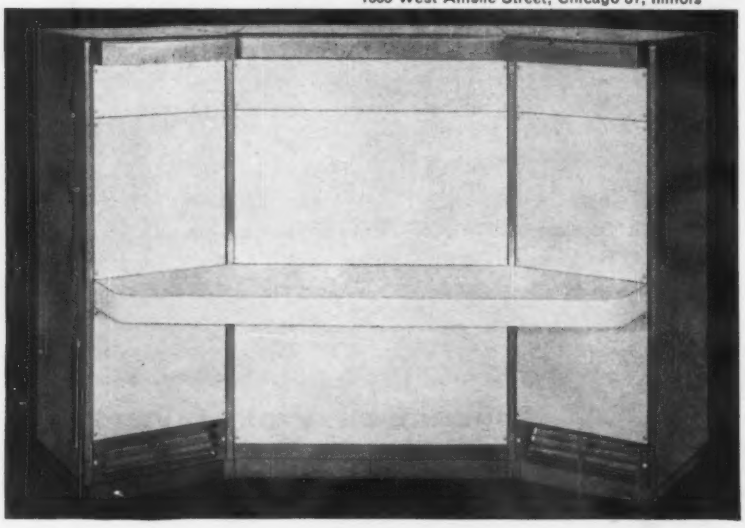
Amco is your one complete source of Modular Instrument Enclosure Systems and Accessories. Write today for catalog of complete specifications.

Custom

REALISTIC 3 WEEK DELIVERY

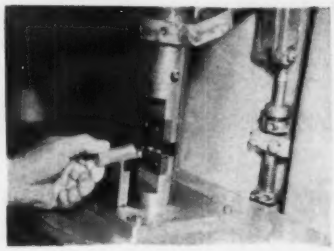
Factory trained representatives in principal cities of U.S. and in Canada.

AMCO ENGINEERING CO.
7333 West Ainslie Street, Chicago 31, Illinois



as she works, loads a batch of blocks face up in recesses in a tray. Springs are inserted into each of the four holes in a block, then the four silver-plated, flat-head contacts. Each block is then loaded into a jig which forces the small ends of the pins through the holes. The protruding ends are placed between plates in a die on an air press and swaged Leads are soldered to the flattened ends, which cannot re-enter the holes. A similar block, with mating contacts, is fitted to the end of the tone arm. Flat-head contacts, with hollow shanks, are pressed into the blocks, Leads are inserted in the hollow end and secured with a drop of solder.

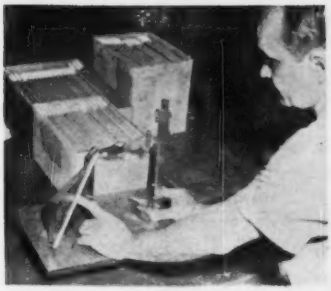
Blocks are assembled in tray



Ends of contact pins are swaged

The tone arm is made with a bend just behind the holder. The bend is used as a reference point for machining and gaging. Accuracy of the bend is first established, to a tolerance of one-third degree, by placing the bent tubing in a channel milled in a steel plate. Pivot and lead wire access holes are drilled in a fixture which clamps the tube at the bend. The straight section of tubing is held in V-grooved blocks, fitted with drill bushings at hole locations. Hole positions are checked on a go-no-go gage similar to the bend checker. Gage pins are inserted through bushings in blocks at the hole locations.

A counterweight is placed on the long end of the tone arm. This end is screw-threaded by rolling, rather than cutting, to preserve tube wall



Tone arm bend is checked in channeled gage

thickness. The weight is not tapped. Instead, rubber rings are fixed in grooves inside the weight. The weight is pushed on and fine adjustments are made by rotating the weight so the flexible rings move on the tube threads. The rings also provide acoustic isolation.

The arm is balanced on a gimbal mounted in a vertical bearing which allows the arm to rotate horizontally. Its hollow shaft passes through the bearing. The bearing consists of a cylinder with bearing balls in the top race and silicone-impregnated composition at the bottom. The top of the shaft is an inverted cone, which centers itself in the ball bearing when the assembly is made in an arbor press. Leads from the cartridge contacts are passed through the tube and down the hollow shaft.

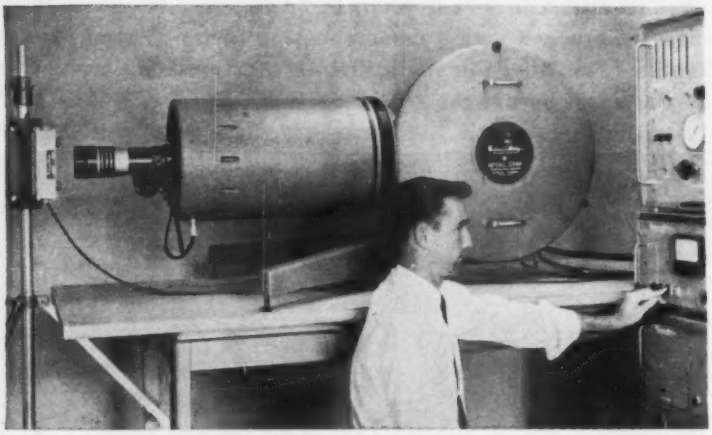
Component Feeder

Bowl feed unit for axial lead components feeds into plastic hopper which handles a specific component size. It can be used as an input attachment on lead straightening, testing, orienting and taping equipment made by Universal Instruments Corp., Binghamton, N. Y.

ENGINEERING IS PART OF THE RELIABILITY PATTERN AT ELECTRO-TEC
Highly creative, but infinitely profound engineering is basic to the reliability pattern at Electro-Tec. A product is designed with built-in reliability. It doesn't stop with basic design . . . all phases of engineering proceed with a comprehension of the natural laws that insure reliability—the spark that extends product capability and performance beyond the expected. ELECTRO-TEC CORP., South Hackensack, N. J.—Blacksburg, Va.—Ormond Beach, Fla.

CIRCLE 117 ON READER SERVICE CARD 117

New On The Market



Streak Camera

CONTINUOUS WRITING

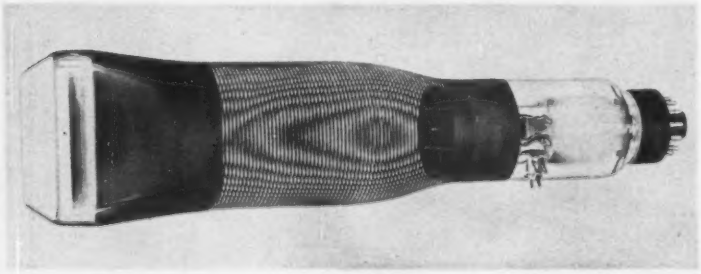
A NEW sweeping image camera that produces an uninterrupted streak image 50 inches long on 35-mm film and which is always in recording condition during operation has been developed by Beckman & Whitley, Inc., San Carlos, Calif. The camera can be used for the documentation of randomly occurring events which are not suitable for synchronization with instrumentation.

Writing rate for the new camera is 9 mm per microsecond, at a maximum mirror speed of 3,600 rps. Time resolution is 5 x 10^{-9} seconds or better, and minimum total writing time is 145 microseconds.

Camera design includes: a beryllium rotating mirror that is essentially distortion free at operating speeds; an all-mirror, axially aligned relay optical system that permits operation in the high ultraviolet region; a film-track configuration which gives a flat film plane and optimum assessment curve; and a transistorized automatic turbine-speed monitor that provides an over-speed safety cutout.

Other features include the ability to operate in various positions, daylight film loading, and arrangements to permit operation as a synchronized streak camera where required.

CIRCLE 301 ON READER SERVICE CARD



Cathode Ray Tube

FOR TRANSISTORIZED OSCILLOSCOPES

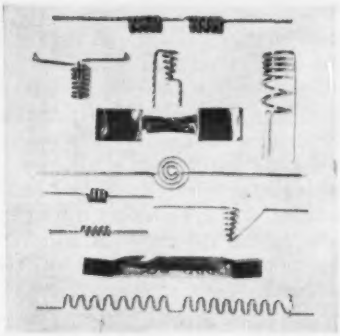
A FLAT-FACE cathode ray tube designed to meet space and power limitations of transistorized oscilloscopes now is available from the Electronic Tube Corporation, 1200 E. Mermaid Lane, Philadelphia, Pa.

Designated ETC Type 31SBP, the new 3¼ x 2¾ flat face rectangular tube combines low deflection factors with excellent light output at modest voltages. These properties eliminate the need for multistage vertical amplifiers or large power supplies in sensitive, wideband oscilloscopes.

Built to MIL-E-1D specifications for use in portable oscilloscopes developed for the Navy, the tube has a minimum useful scan of 2½ inches horizontally and 2¼ inches vertically, using electrostatic focus and deflection. A linear post accelerator and a geometry adjust electrode maintain deflection uniformity and minimum pattern distortion.

The tube is priced at $150 with 4 to 6 weeks delivery.

CIRCLE 302 ON READER SERVICE CARD



Filaments and Boats

FOR COATINGS

A NEW complete line of tungsten, tantalum and molybdenum filaments and boats are now available in a variety of sizes and shapes from Electronics Division of Allen-Jones, Inc., 1345 Gaylord Ave., Long Beach, Calif. Manufactured for use in high vacuum as an evaporation source, these filaments and boats are processed for purity and accuracy. All parts are stress relieved for long life and to maintain their geometry during use. Uses for these filaments and boats include: electronic component processing, coating of optics, plastics and toy decorative coating, precision instrumentation manufacturing, and vacuum metalizing in basic research laboratories.

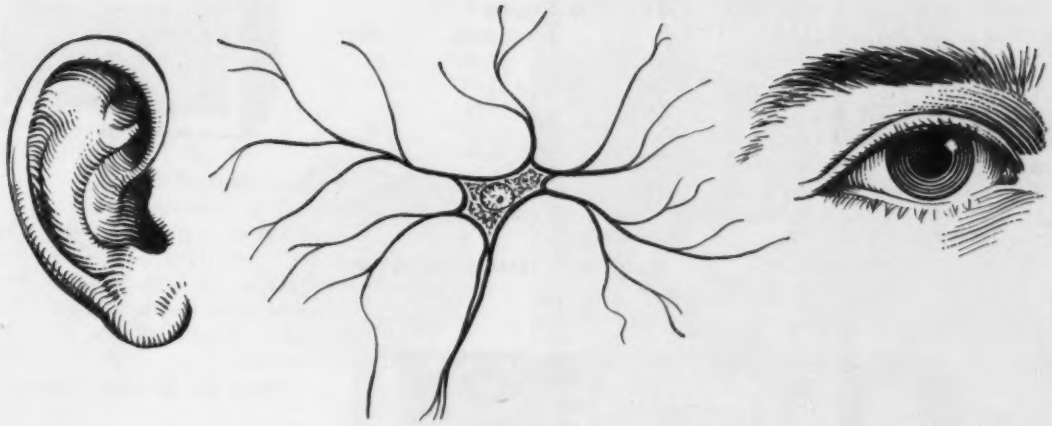
CIRCLE 303 ON READER SERVICE CARD

Computer Diodes

WITH FAST RECOVERY

A GOLD-BONDED silicon diode with a guaranteed recovery time of 0.5

WHAT GOES ON HERE?



Bell Telephone Laboratories' new electronic "nerve cell" is a step toward finding out

One fascinating area of communications has long resisted exploration—what happens inside the nervous system when you see, or when you hear.

This area is of special interest to telephone science; knowledge of how the nervous system handles sound and picture signals can help determine what information is essential to perception. This in turn may lead to more efficient communication instruments and systems.

To probe the mystery of nerve activity, Bell Telephone Laboratories scientists have developed an electronic model of a living nerve cell or neuron. Consisting of transistors, resistors, capacitors and diodes, the "artificial neuron" exhibits many of the characteristics of a living neuron; for instance, "all-or-none" response and fatigue.

In one experiment at Bell Laboratories, a network of artificial neurons is subjected to a stimulus from light through a set of photocells. The network can distinguish specific patterns of light and dark, thus duplicating roughly some of the eye's basic reactions to light. Similar studies are underway to explore our hearing processes.

At present, too little is known about neural action to permit exact electronic duplication. But experiments with artificial neurons can provide suggestive clues, contributing to a stimulating interplay between electronics and neurophysiology which may help workers in both disciplines.

The human nervous system, including the brain, is the most efficient and versatile data processing system known; and data processing is an essential part of communications. The artificial neuron provides a new approach to investigating and understanding basic nerve network functions. It is a fresh example of how Bell Telephone Laboratories constantly explores new frontiers to improve America's communications system, now and in the years ahead.

Network of neurons is assembled by L. D. Harmon of Bell Laboratories, the initiator of this new research. Many kinds of assemblies are possible.

A single artificial neuron. It delivers electrical impulses when stimulated, like a living cell. Neurons are also being used for research into hearing.

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

nanosecond is now available from the semiconductor division of Hughes Aircraft Co., 500 Superior Ave., Newport Beach, Calif.

The diode switches and recovers so fast that its actual storage time cannot be measured on high speed traveling wave oscilloscopes.

The guaranteed recovery time of 0.5 nanosecond is given only to accommodate the measuring limits of standard sampling oscilloscopes.

In development tests the diode switched from ten milliamps forward current to minus six volts reverse voltage with less than 0.2 nanosecond recovery time.

Typical capacitance for the total diode is 0.7 picofarad. It also has a rectification efficiency of 25 percent at 13.5 Gc.

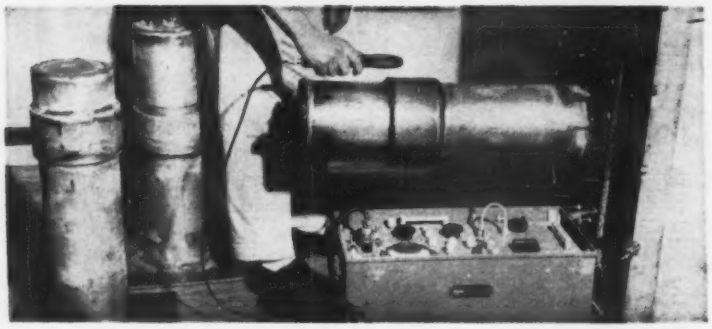
Five diode types are being offered in the standard glass package.

Typical unit prices are:

	1-99	100-999	1,000-9,999
HD5000	$2.60	$2.00	$1.80
HD5001	2.21	1.70	1.53
HD5002	2.08	1.60	1.44
HD5003	1.56	1.20	1.08
HD5004	1.17	0.90	0.81

The diode is now available through semiconductor field sales engineers.

CIRCLE 304 ON READER SERVICE CARD



R-F Shielding Materials

COATINGS AND LUBRICANTS

MATERIALS that can be used to insure the radio-frequency integrity of equipment, components, housings and even shielded enclosures has been developed by Emerson & Cuming, Inc., Canton, Mass. The materials have been extensively tested in the frequency range from 10 Kc to 10,000 Mc for both magnetic and electric field shielding effectiveness. In many cases, these Eccoshield materials have converted poorly shielded equipment housings into those having insertion losses greater than 100 db. Included in the line are: a conductive compound for caulking seams and for conduit threads; a conductive adhesive, epoxy based; a conductive lubricating grease; a conductive surface coating for shielding; a honeycomb vent for shielded equipment enclosures; and finger stock for doors and for removable panels.

CIRCLE 305 ON READER SERVICE CARD

100 Mc Counter

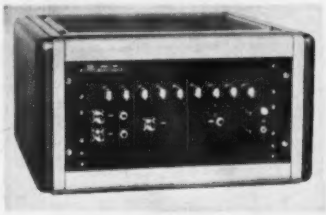
TIMES INTERVALS TO 10 NSEC

A 100 MEGACYCLE transistorized gated counter, for counting, time interval and frequency measurements has been developed by Eldorado Electronics, 2821 Tenth St., Berkeley, Calif.

The Model 1050 gated counter counts random events with better than 10 nanosecond double pulse resolution, functions as a time interval meter to measure duration to 10 nanoseconds and measures frequency to 100 Mc.

Nine digits of storage with in-line (Nixie) display are used. As a counter, it may be started or stopped remotely or locally with a built-in electronic gate.

As a time interval meter, the counter requires an external oscillator; as a frequency meter, it requires an external time base, but can be supplied with these components built-in.



The counting logic uses five binaries instead of four. Each of the five binaries is required to operate at only one-fifth of the maximum frequency of the instrument. Price is $4,875, with 75 days delivery.

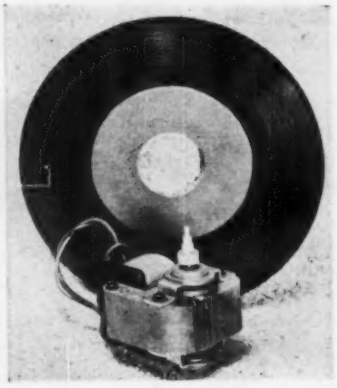
CIRCLE 306 ON READER SERVICE CARD

Synchronous Motors

HYSTERESIS FEATURES

A SYNCHRONOUS motor which combines the features of hysteresis motors with the lower cost of shaded pole motors has been developed by The Alliance Manufacturing Company, Alliance, Ohio. Comparable in price to the standard two or four pole shaded motor, the motor was designed for phonograph applications.

The new motor uses permanent magnetization of both ends of an induction motor to give the rotor a combination of synchronous and induction torque. Thus, the motor permanently locks into synchronous speed and is free from slip, making it suitable for driving phonographs, tape recorders and similar mechanisms.



Other applications include tran-

it's read more by all 4!

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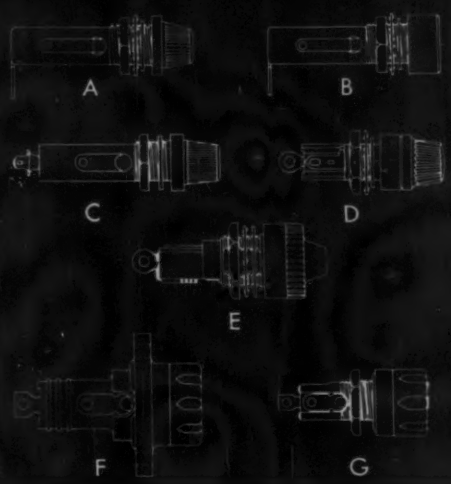
OTHER FUSE POSTS MAY LOOK LIKE THESE... BUT ONLY LITTELFUSE HAS PDQ*

A Fuse Post to meet every application—every requirement.



EXTRACTING FUSE POST! Fuse is held in end of removable knob for quick, safe and easy replacement of blown fuse. Safe "dead front" fuse mountings assured. U/L Approved.

A—3AG Fuse Post (finger operated knob)—No. 342001

A—8AG Fuse Post (finger operated knob)—No. 372001

B—3AG Fuse Post (Screwdriver Slot)—No. 341001

B—8AG Fuse Post (Screwdriver Slot)—No. 371001

C—4AG Fuse Post (Finger Operated Knob)—No. 442001

D—3AG Miniature Fuse Post (Finger Operated)—No. 342012

E—NEW INDICATING 3AG FUSE POSTS! (344,000 series) It Glows When The Fuse Blows. Long life incandescent bulb for low voltage ranges—2½-7V; 7-16V; 16-32V. New high degree vacuum neon lamp for high voltage ranges for greater brilliance and visibility—90-125V; 200-250V.

WATERTIGHT FUSE POSTS Specially designed for use where excessive moisture is a problem.

F—5AG Watertight Fuse Post. Has flange mounting.—No. 571004.

G—3AG Watertight Fuse Post—No. 342006

G—4AG Watertight Fuse Post—No. 442006

For complete details on these items and quotations on special application requirements, write to:

*Precision Engineering
Design Know-how
Quality Craftsmanship

LITTELFUSE
DES PLAINES, ILLINOIS

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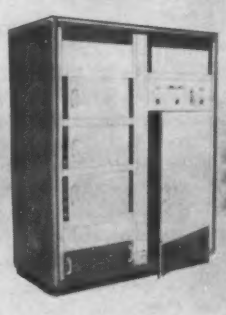
NEXT QUESTION . . .

HOW DOES IT PERFORM?

The RADAR QUANTIZER Provides Answers

By utilizing the RADAR QUANTIZER®, the Army Ordnance Corps can track the Pershing missile in flight with a position plot resolution of ±2½ feet — a resolution heretofore impossible. The Quantizer, developed under contract of the Army's Diamond Ordnance Fuze Laboratories, is a millimicrosecond time interval meter. It converts the radar electrical signals into digital code format and feeds a storage tape, *as fast as the dynamic data occurs.* As a result, engineers can follow the missile's exact flight path on the ground with the aid of digital computing equipment — making optimum use of the radar equipment's full capability, down to the Quantizer's instantaneous resolution of ±10 millimicroseconds!

If you have data processing requirements where it is desirable to measure time intervals down to ten millimicroseconds or less, and read the result out in digital format *while the data occurs,* contact Computer Equipment Corp. for full details on how the QUANTIZER can be applied to your system.



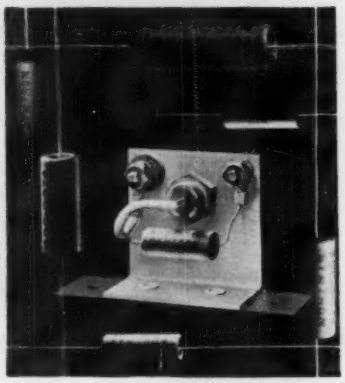
Computer Equipment Corp.

11612 W. OLYMPIC BLVD., LOS ANGELES 64, CALIF.

GRANITE 8-0464 TWX WLA 6650

scription turntables, timer applications, data processing, and equipment associated with recording charts and graphs.

CIRCLE 307 ON READER SERVICE CARD



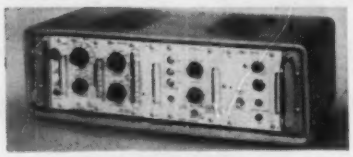
Selenium Surge Suppressor

PROTECTS DIODES

A SELENIUM surge suppressor that protects silicon diodes against burnout from voltage transients has been developed by the Semiconductor Division of Syntron Company, Homer City, Pennsylvania. The device, called Surge Stop, allows reduction in size of silicon diodes in many applications to about 30 percent above rated piv, compared to 200 percent over-design usually required. The device, whose reverse characteristics dissipate energy found in transient voltages, is a selenium cartridge rectifier that is shunted across the silicon diode.

Maximum discount net prices range from $0.70 to $1.00 in quantities of 1,000 with delivery about one week from the receipt of the order.

CIRCLE 308 ON READER SERVICE CARD



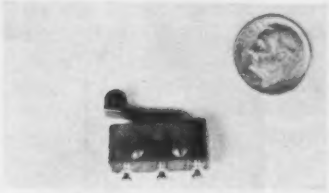
Pulse Generators

TRANSISTORIZED

ELECTRO-PULSE, INC., 6711 S. Sepulveda Blvd., Los Angeles 45, Calif. Modular plug-in versatility, completely solid state design, and broad performance capabilities are features of the 3500 series pulse gen-

erators. Single and double pulse versions are available with repetition rates to 2 Mc and pulse widths and delays continuously variable to 1,000 μsec. Output pulse rise times are ultrafast: 0.02 μsec or faster with 13 v amplitude from an output impedance of 50 ohms. A constant impedance 50-ohm attenuator provides 40 db attenuation. Optional plug-in modules for various pulse repetition rates, delays, widths, and output characteristics are available to meet specific requirements.

CIRCLE 309 ON READER SERVICE CARD



Subminiature Switch

WITH ROLLER ACTUATOR

CROWN ELECTRIC, Box 171, Orange, N. J. Economy, compatible with meeting military specifications, is the policy in offering this special switch at prices as low as $1.80 each, in lots of 1 to 9. Lower prices for larger quantities. Guaranteed to break 5 amp resistance for a minimum of 150,000 cycles. All parts, including roller and leaf actuator, non-magnetic stainless steel. Available spdt or dpdt.

CIRCLE 310 ON READER SERVICE CARD

Silicon Rectifier

MEDIUM HIGH POWER

TRANS-SIL CORP., 55 Honeck St., Englewood, N. J., announces a compact rectifier stack capable of handling up to 4 amperes in half wave and 20 amperes in full wave

a new name with a 50 year tradition in electronics

NEMS-CLARKE, a division of Vitro Corporation of America, has produced the finest in precision electronics since 1909. Now, this equipment will be produced and marketed by Vitro Electronics under the Nems-Clarke brand name. In communications, remember Vitro Electronics, the world's foremost designer and producer of special purpose receivers.

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CIRCLE 123 ON READER SERVICE CARD

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We can usually design and deliver samples of toroidal coils and filters to your exact specifications on short notice.

We are equipped to produce toroids and toroidal filters with outstanding temperature stability to either commercial or military requirements.

Whether your application is communications, missiles or data reduction systems, our facilities backed by a quarter of a century of service to industry assure you of a solution . . . fast. Many engineers find our folder "Toroids and Filters" helpful in developing specifications. A copy is yours for the asking.

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CIRCLE 204 ON READER SERVICE CARD

. . . Electrical Coil Windings

. . . WIRE SIZES #6 TO #56

For 43 Years . . . specializing in all types of coils to customers' specifications. Design or engineering assistance available on request.

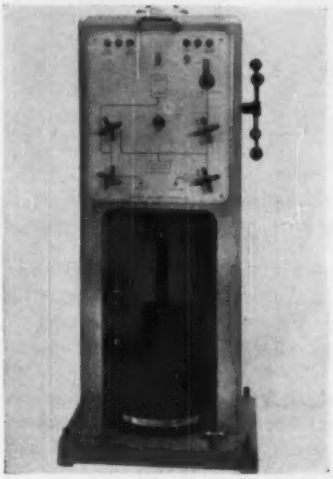
COTO-COIL CO., INC.

SINCE 1917

65 Pavilion Avenue Providence 5, Rhode Island

circuits. The new series 2R units, of double diffused silicon junction construction are designed for magnetic amplifier, power supply, and other medium power applications. Forward voltage drop does not exceed 1.0 v, and reverse leakage does not exceed 1.0 v, at 25 C. These rectifiers can be used at ambients to 150 C without perceptible changes in characteristics. Four, eight, twelve and twenty amp half wave, center tap, full wave bridge and star configurations are available from stock.

CIRCLE 311 ON READER SERVICE CARD



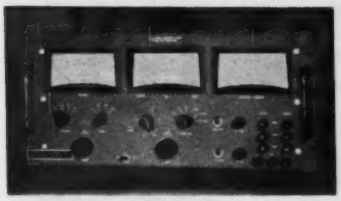
Pressure Balances

EASY CALIBRATION

AMERICAN INSTRUMENT CO., INC., 8030 Georgia Ave., Silver Spring, Md. Effortless calibration of pressure gages and transducers, rapid enough for production line calibration projects, is now possible with a new line of pressure balances. The balances give pin-point pressure values up to 100,000 psi, with accuracies up to 1/20th of 1 percent. Dials of the gages being calibrated can then be set to these extremely accurate values to insure correct readings. The pressure balances incorporate automatic weight lifters to raise or lower weights by flipping a toggle valve and provide a series of pilot lights to indicate when balance has been achieved, thus eliminating former bottlenecks of manual handling of weights and time lost in obtaining final balance. Weights not in use may be subtracted from the weighing system

without removing them from the balance.

CIRCLE 312 ON READER SERVICE CARD

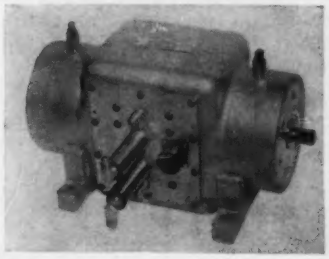


Transistor Tester

PRECISION UNIT

COMMAND SYSTEMS, INC., 1135 N. Stanford Ave., Los Angeles 59, Calif. Model TTS-100 transistor test set is designed for making precision measurements of the d-c characteristics of power transistors as listed on the manufacturer's specification sheet. Accurate data is obtained rapidly for design and inspection purposes. Leakage currents, d-c gain, transconductance, input impedance, power conductance, saturation voltage and saturation resistance are measured. Punch-through voltage is determined without damaging the transistor. Separate connections are provided for measuring the voltage at the transistor terminals to eliminate errors in measuring the saturation voltage. A heat sink base containing adapters for various types of transistors is available as an accessory.

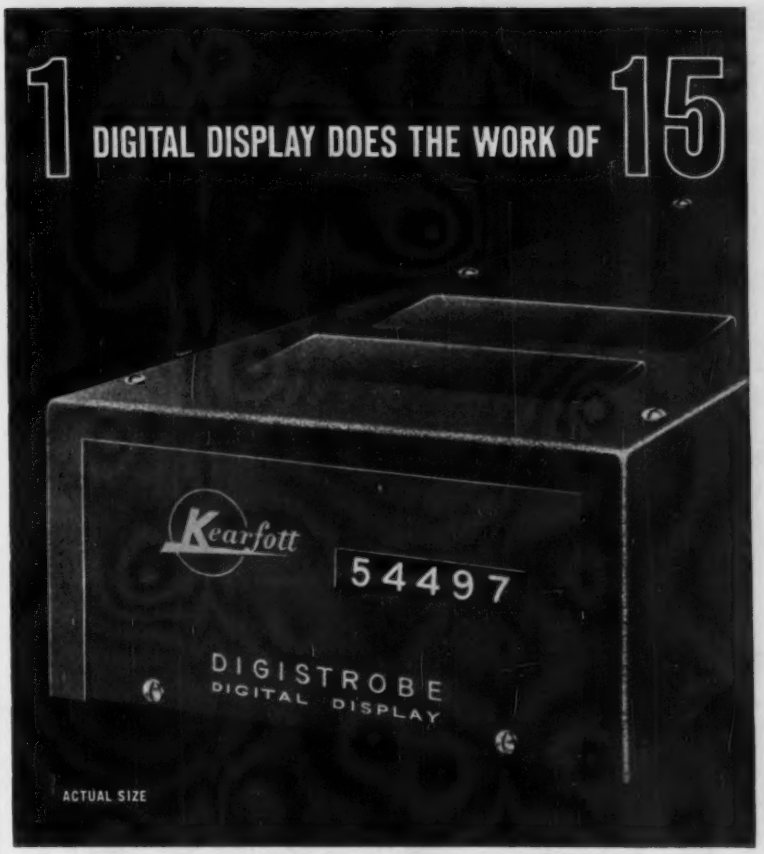
CIRCLE 314 ON READER SERVICE CARD



Torque Meter

HIGH SPEED

B & F INSTRUMENTS, INC., 3644 N. Lawrence St., Philadelphia 40, Pa. Model F2C2A is a true high-speed torque meter capable of accurately transmitting torque signals through 50,000 rpm. This model is being built in ranges from 0 to 100 in./lb full scale through 0 to 1,000 in./lb



NEW KEARFOTT DIGISTROBE* DISPLAY

Kearfott's new, highly compact Digistrobe digital display utilizes the stroboscopic principle to produce an exceptionally high-definition readout in the actual size shown here. Through the use of a unique shutter arrangement, a single diode-encoding matrix is shared by all columns (5 in the standard model), resulting in substantial savings in electronic components and circuitry. The fast response time of the Digistrobe (56 milliseconds transition from one five-digit quantity to a totally different one) permits a single unit to sample several different inputs on command through an input selector switch. Up to 15 individual displays of existing types can thus be replaced by a single Kearfott Digistrobe!

Incorporating only two moving parts and exclusively solid-state switching circuitry, the Digistrobe has extremely long life expectancy and requires minimum maintenance and service. Operation is directly from the output register of a computer, counter or allied equipment, eliminating the cost of intervening circuitry. Two years of extensive laboratory tests assure compliance with Kearfott's rigid standards of quality. For complete data and specifications, write for Digistrobe bulletin.

*Kearfott Trademark

GP

KEARFOTT DIVISION
GENERAL PRECISION, INC.

Little Falls, New Jersey

CIRCLE 125 ON READER SERVICE CARD

How to double performance of your magnetic tape recorders

Now you can record 125-kc data at 30 ips instead of 60 on most existing data recorders. How? By using the new Ampex FR-600 for playback. New record/playback capability in the FR-600 saves previous equipment from obsolescence with some added benefits of its own—for example, recording 500 kc at 120 ips.

Your curiosity whetted? See our full page on the FR-600 in November 4 ELECTRONICS, or write for descriptive literature, and we'll send the ad along too.

AMPEX

AMPEX DATA PRODUCTS COMPANY
Box 5000 Redwood City, California

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Immediate Shipment

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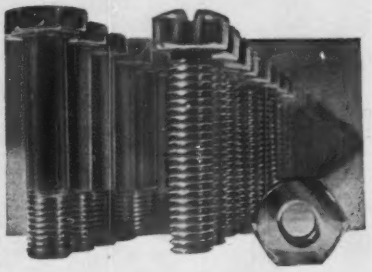

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Your order, large or small, filled "fast" from the world's largest stock of stainless steel fasteners. AN, MS, Commercial specifications in stock. Rigid quality control, mass production economies. Special stainless steel fasteners also manufactured to your exact requirements on extremely short notice. Just send blueprint or specs for quotation. Full range of raw material, on hand, assures prompt service.

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5822 West Washington Blvd., Culver City, Calif.
Phone: WEbster 3-9595 TWX LA 1472

full scale with 0.6 pd male spline shaft ends. Larger versions of this model with 0.8 pd male spline shaft ends will transmit torque through 2,500 in./lb full scale and a still larger version with 1.2 pd splines will cover ranges up to 10,000 in./lb full scale.

CIRCLE 316 ON READER SERVICE CARD

Delay Lines
COMPUTER-TYPE

CONTROL ELECTRONICS CO., INC., 10 Stepar Place, Huntington Station, L. I., N. Y. A lumped constant delay line that is totally encapsulated in epoxy resin has been developed. Utilized internally in computers, these units eliminate the need for terminal boards which commonly trap moisture. Models F-577A and F-578A are moisture proof, reliable and of inexpensive molded construction. The F-577A has a total delay of 10.0 μsec (nominal). Rise time is 0.5 μsec max. Unit features multitaps every 0.20 μsec. The F-578A features a total delay of 15.0 μsec (nominal) with a rise time of 0.4 μsec max. Multiple taps on this unit are featured every 0.125 μsec. Both models have an impedance of 400 ohms and an operating temperature to 125 C. Delay and impedance can be modified to suit individual requirements.

CIRCLE 317 ON READER SERVICE CARD

Ternary Alloys
FOR SEMICONDUCTORS

ALPHA METALS, INC., 56 Water St., Jersey City 4, N. J. Up to 5 percent germanium, alloyed with indium-gallium and fabricated into foil and preforms for semiconductor devices, is now being produced. The resulting ternary alloys are available in the following forms and sizes: Spheres from 0.005 in.; tolerances are as close as 0.0001 in. Foil from 0.0005 in. thin. Disks

range upward from 0.005 in. Rectangles from 0.040 in. to 0.015 in. Squares start at 0.020 in. Washers may be had with a 0.020 in. i-d and a land area as small as 0.005 in.

CIRCLE 318 ON READER SERVICE CARD

Mesa Computer Diode
MICROMINIATURE

MICROWAVE ASSOCIATES, INC., Burlington, Mass., announces a microminiature mesa computer diode that utilizes a new method of directly fusing glass to the silicon junction to accomplish a high reliability hermetic seal. New diode is only 0.080 in. long and 0.070 in. in diameter and utilizes leads of gold plated ribbon 0.004 in. by 0.020 in. that can be either soldered, tweezer-welded or compression bonded. Unit is primarily designed for high reliabiltiy, high density computer circuits. Operating temperature range extends from − 65 C to + 200 C, recovery time 2.0 nanoseconds, leakage current of 0.015 μa at − 40 v, with a power dissipation of 50 mw at 25 C. This new unit is available in engineering quantities for evaluation.

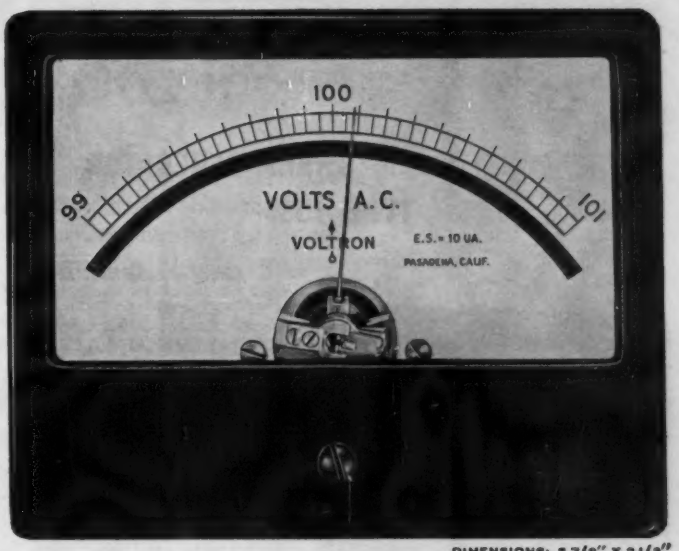
CIRCLE 319 ON READER SERVICE CARD

True RMS Voltmeter
COVERS WIDE RANGE

BALLANTINE LABORATORIES, INC., Boonton, N. J., announces a true rms voltmeter capable of measuring a wide range of complex waveforms to ¼ percent accuracy. Measurements with this model 350 are not limited to sinewaves to obtain the accuracy. The instrument provides

0.1%

ONE/TENTH PERCENTERS



DIMENSIONS: 2 7/8" X 3 1/2"
3 3/4" X 4 3/4"

EXPANDED SCALE PANEL VOLTMETERS

AC or DC, With Accuracy of 0.1%!

This new degree of accuracy is made possible by Voltron's combination of a taut band meter movement and an extremely precise expansion network.

The static friction found in conventional pivot and jewel type meters is completely eliminated by the taut band movement, which also provides extremely rugged construction. The meter maintains its 0.1% accuracy in any position and can be used with either a magnetic or non-magnetic panel.

Write for details, Bulletin 603A — or see your local sales rep.

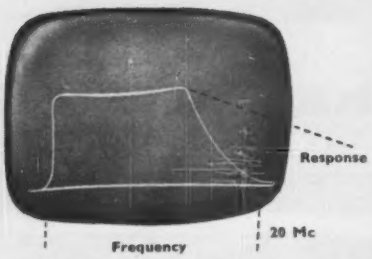
VOLTRON [illegible]

1020 So. Arroyo Parkway, Pasadena, California

CIRCLE 127 ON READER SERVICE CARD

DIRECT DISPLAY OF RESPONSE UP TO 20 Mc

The Marconi 20-Mc Sweep Generator can be used in conjunction with any oscilloscope for direct display of video response characteristics up to 20 Mc. The instrument is designed for precise measurement. Frequency is indicated by crystal-controlled marker pips; and a special circuit provides for differential amplitude measurements, enabling relative response to be determined with a discrimination better than 0.01 dB.



MARCONI 20-Mc SWEEP GENERATOR TYPE 1099

Abridged Specification

Frequency Swept Output: Frequency Range: Lower limit 100 kc, Upper limit 20 Mc. Output level: Continuously variable from 0.3 to 3 volts. Output Impedance: 75Ω. *Time Base:* Repetition Rate: 50 to 60 cps. Output for c.r.o. X deflection: 250 volts. *Frequency Markers:* At 1 Mc intervals; every fifth pip distinctive and crystal controlled. Tubes: 6AK5, 6BH6, 5763, 6BJ6, 6CD6G, 6BE6, 12AT7, 12AU7, 6C4, 5V4G, OA2, 5651.

Send for leaflet B124/A.

MARCONI INSTRUMENTS

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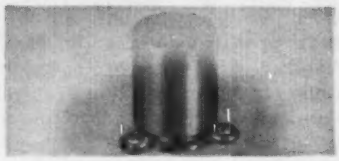
Tel: LOwell 7-0607

Canada: Canadian Marconi Co • Marconi Building • 2442 Trenton Ave • Montreal 16
MARCONI INSTRUMENTS LTD • ST. ALBANS • HERTS • ENGLAND

TC124

a 5-digit Nixie read-out. Voltage range is 0.1 v to 1,199.9 v. Frequency range of the input signal is from 50 cps to 20 Kc with harmonic content to 50 Kc. An outstanding feature is the wide range of waveforms which can be measured to ½ percent accuracy, that is, from sinewaves to squarewaves so long as the ratio of peak to rms is not over 2. This means, for example, that a sinewave with 50 percent harmonic distortion can be accurately measured. The ½ percent accuracy is reduced to ¾ percent for voltages above 300 and for frequencies below 100 cps and above 10 Kc. Price is $720.

CIRCLE 320 ON READER SERVICE CARD



Synchro Clamp
MINIATURIZED

TIMBER-TOP, INC., 38 Brooklyn Ave., Freeport 2, L. I., N. Y., announces the Mini-Synclamp, a quick-release, self-locking synchro clamp that permits the easy and secure fastening of size No. 5 through size No. 11 miniature components to any base. Quick-release is attained by the use of a nylon insert of DuPont Zytel 103 making the clamp and screw an integral unit. When the screw in the clamp is tightened the insert is squeezed thus allowing the screw to self-align perfectly. Once aligned, the Mini-Synclamp locks and unlocks by turning the screw against integral stop. This application is especially ideal in hard-to-reach places. Units meet and exceed MIL-E-5272 specs and are functional up to 350 F. They are available from stock in 4 different grip thicknesses: 0.031, 0.047, 0.062, and 0.093.

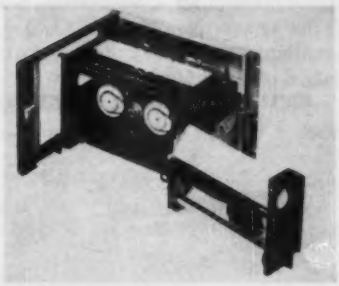
CIRCLE 321 ON READER SERVICE CARD

Conversion System
VOLTAGE TO DIGITAL

LINK DIVISION, General Precision, Inc., Binghamton, N. Y., announces a high-speed voltage to digital conversion system which incorporates

a multiplexer. The solid state, 100 channel unit—called a precision multiplex converter—employs advanced error and drift correction techniques to maximize conversion accuracy. Computation and conversion loops are integrated into one system. The design offers unlimited possibilities for channel expansion or multiple operation modes.

CIRCLE 322 ON READER SERVICE CARD

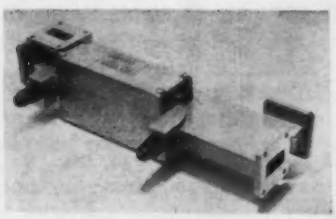


Strip-Chart Recorders

FLUSH-MOUNTING

TEXAS INSTRUMENTS INCORPORATED, Geosciences & Instrumentation Division, 3609 Buffalo Speedway, Houston 6, Texas. New flush-mounting "servo/riter" potentiometric strip-chart recorders are offered in wide and narrow chart, single and dual channel models. They feature swing-out chart carriages and a slide-out chassis for extra accessibility. They also have an illuminated scale for greater visibility at a distance. A zero adjustment provides for zero settings over the entire scale. The instruments have a span step response rating of 0.5 sec. Featuring power sensitivity of better than 10^{-6} w with off-balance input resistance of 4 megohms, these recorders are available in 1-100 d-c millivolt ranges.

CIRCLE 323 ON READER SERVICE CARD



Ferrite Circulators

HIGH POWER

RANTEC CORP., Calabasas, Calif., has available a new line of high power

FASTEST DRAW ON THE MISSILE RANGE

GIANNINI'S PYROGYRO*

Introducing PYROGYRO! THE one-shot free (or rate) gyro for short range missiles that offers more simplicity, increased reliability, fast run-up, light weight, expendability! Another outstanding new product of Giannini's unequalled depth of experience in INERTIAL INSTRUMENTS, AIR DATA INSTRUMENTS, SERVO COMPONENTS... for better measurement and control... everywhere on earth and above it.

SIZE: 2½ x 3⅛ x 3½ envelope.

SIMPLICITY: Only 5 moving parts, 25 parts total, for radically improved reliability.

FAST RUN-UP: Gases generated by the pyrotechnic charge spin rotor to 36,000 rpm in less than 100 millisecs.

DRIFT RATE: 1° per min. during first 4 minutes of operation.

LIGHT WEIGHT: 8 oz. all-aluminum except rotor and potentiometer.

EXPENDABILITY: Cost is surprisingly low in production quantities.

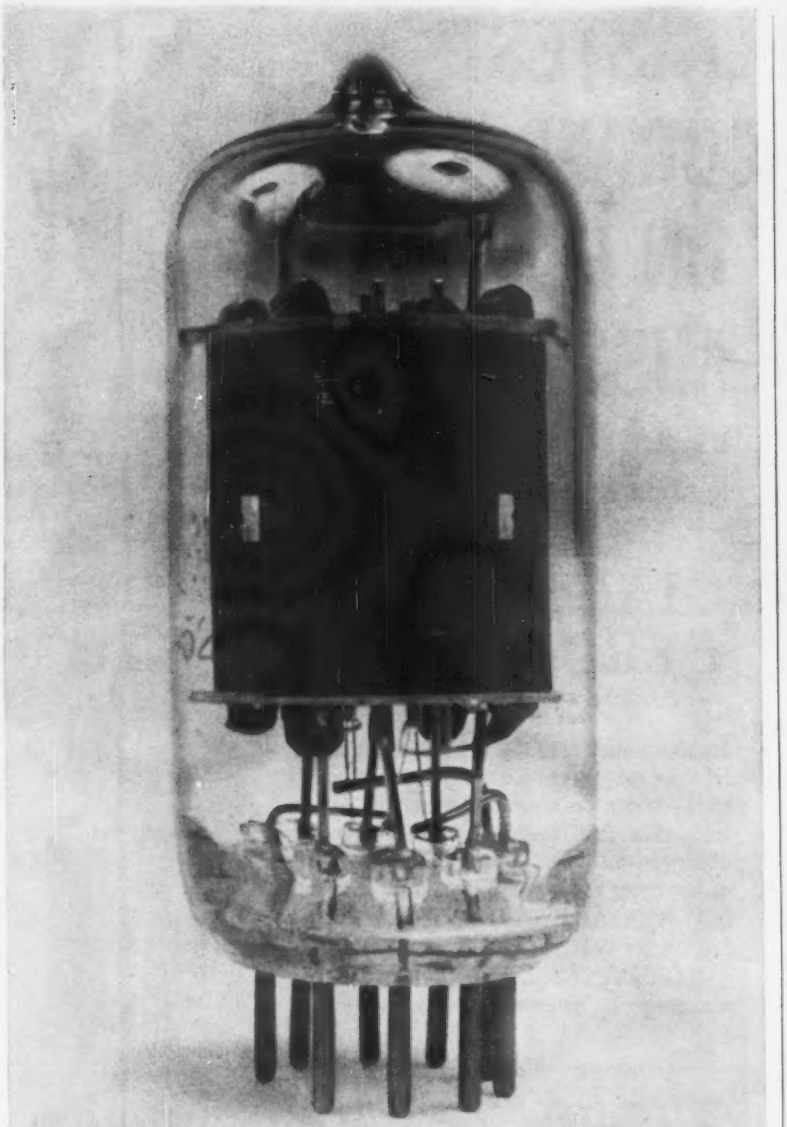
*TRADEMARK

Giannini Controls Corporation

A NAME TO PLAN WITH

1600 S. Mountain Duarte, California

GCC 0-8



SHIP IT FAST! SHIP IT SAFE!
SHIP IT AIR FRANCE JET!

Tubes...condensers...diodes...rectifiers. The fast safe way to ship all electronic parts overseas is Air France Jet. Speed fragile items non-stop to Paris, gateway to all Europe, on 10-mile-a-minute Boeing 707 Jets. Cargo compartments are pressurized...temperature-controlled...perfect for even the most sensitive parts. Total of over 21 jet flights a week—from New York, Chicago, Los Angeles. Fast jet connections throughout Europe, Africa and the Middle East. You save money on crating, shipping weights. Lower insurance costs, too. And no one offers lower jet cargo rates than Air France. Air France speeds cargo to more cities in more countries than any other airline.

circulators in X and C-bands. Units employ lightweight aluminum construction and are made with integral water jackets for cooling when used at the higher power applications. Model CXL-200 pictured on p 129 is typical of these advanced ferrite circulators and has the following specifications: frequency range 8,500 to 9,600 Mc; isolation 20 db minimum; loss 0.6 db maximum; vswr 1.2 to 1 maximum; power handling 1 megawatt peak, 1,000 w average. Model CXL-200 is available on 30 day delivery at a price of $694.50.

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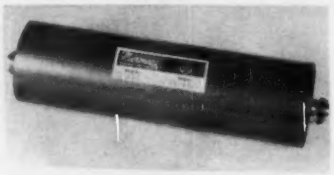

Coaxial Isolators
COVER UHF TO X-BAND

MICROMEGA CORP., Venice, Calif., has developed a line of microwave coaxial isolators. In addition to a group of standard broadband isolators, company engineers have custom designed many units for special applications. Typical specifications of the broadband units such as model CL140 are: frequency range, 4,000-7,000 Mc; isolation, 20 db min.; insertion loss, 1.0 db max.; vswr, 1.15 max.; size, 6⅝ in. long, 2.0 dia.; connectors, type N. Typical of the custom-designed coaxial isolators is model SL140, with these characteristics: frequency range, 1,900-2,300 Mc; isolation, 20 db min.; insertion loss, 0.6 db max.; $vswr_{IN}$ 1.10 max.; $vswr_{OUT}$ 1.10 max.; size 7.1 in. long, 2.0 in. dia.; connectors, type N. Delivery time is 30 to 90 days.

CIRCLE 325 ON READER SERVICE CARD

Video Detector
MILLIMETER WAVE

MICROWAVE ASSOCIATES, INC., South Ave., Burlington, Mass., announces a new broadband video detector for high tangential sensitivity receiver use over the 40,000-75,000 Mc frequency range. Minimum tangential signal sensitivity over the entire frequency range is −27 dbm for a

receiver bandwidth of 2.5 Mc and 100 Kc low frequency cutoff. Smooth response without resonance power drop out ripples is achieved over the entire frequency range. The MA-441 features a rugged construction suitable for airborne applications. A mica window seal recessed in the detector waveguide input prevents entry of dust, dirt, moisture, etc. No external holder is required. Waveguide connection is provided for adaptation to ridged RG-98/U or to a taper appropriate for standard RG-97/U (MA-803) or RG-98/U (MA-512) waveguide. The diode and whisker are mounted across a section of ridged RG-98/U waveguide for best broadband response. All electrical conducting surfaces are silver plated throughout.

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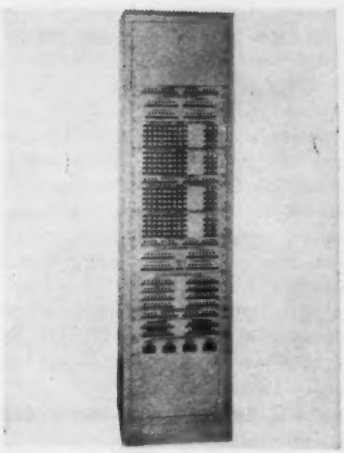

Signal Switching Rack
UP TO 385 INPUTS

EDP CORP., 3501 S. Orange Blossom Trail, Orlando, Fla., has available a signal switching rack which can double the use of test equipment or telemetry equipment. Designed to route wide band data to and from various pieces of equipment, model 248 is ideal for routing telemetry signals to recording or timing devices and oscillographs. One input can be fed to several outputs through the use of parallel jacks; and up to 385 inputs can be handled. Price range is between $5,800 and $6,800, depending on quantity. Delivery is four to six weeks. Other specifications for the unit designed for use with ground equipment for military application are: rack size, 84⅞ in. by 22½ in. by 20

CONTINUED COMMERCIAL EXPANSION AT NCR CREATES IMMEDIATE REQUIREMENTS IN LOS ANGELES FOR:

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Seniors & Intermediates

Experienced graduate E.E.'s with 3 to 5 years in logic design and transisterized circuit design of digital equipment. Assignments will entail logic and circuit design of buffer storage units and digital peripheral equipment.

TRANSISTOR POWER SUPPLY ENGINEER

Per assignment in specifying power supplies for both large and digital systems; supervising the design of supplies internally or by vendors, and evaluating supplies to determine conformance to specifications. Requires knowledge and design experience in solid state computer power supplies, their specification, and associated transister circuitry. Requires experienced graduate E. E. or man with formal training and appreciable practical transistor power supply experience.

TRANSISTOR CIRCUIT ENGINEERS
Seniors & Intermediates

Highly creative positions are available in circuit analysis and design. Duties include: advanced mathematical studies in transistor circuitry, evaluation of transistor circuitry, component studies and keeping abreast of computer circuit advances. Circuit analysis ability and solid understanding of transistor theory essential. E.E. degree required.

PRODUCT ENGINEERS
Seniors & Intermediates

Assignments entail design analysis and technical liaison to develop a producible product; establishment of design requirements from standpoint of cost, product ability and standardization; recommendation of changes for ease of manufacture. Positions require substantial knowledge of manufacturing methods, practices, shop equipment and facilities; solid background in electronic design of digital equipment; E.E. degree.

Confidential interviews can be arranged in Los Angeles or at the Eastern Joint Computer Conference in New York Dec. 13-15. Please send resume now to Norval E. Powell, Personnel Manager.

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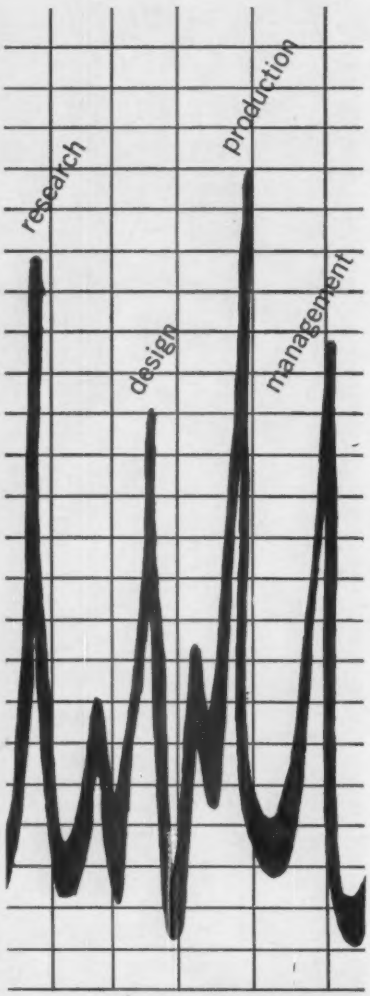

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in.; cross talk, 50 db; cables, RG-58C/U, 53.5 ohms characteristic impedance.

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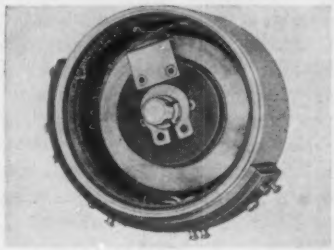
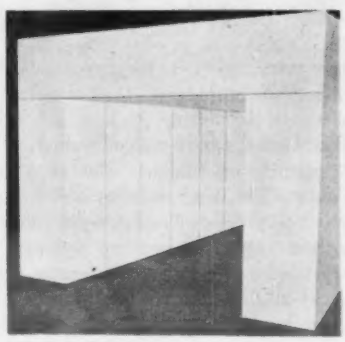


Precision Pot
QUICK-CHANGE SETTINGS

ACCURACY, INC., 4 Gordon St., Waltham 54, Mass. New P32 series Protractatap potentiometers now available. It is possible to change settings (by eye) of the pots in just 30 sec. Using only a pencil point, set taps to ½ deg—save valuable man-hours and the need for special tapping tools. Settings can be arranged quickly and frequently with assurance of precise operation under extremely rigid environmental conditions. Resistance range is 5 K to 250 K, ± 5 percent; mechanical angle, continuous; electrical angle, 320 deg ± 3 deg; linearity, ± 0.25 percent; number of taps, 3 std up to 8 with 0.032 in. increase in 0.969 dimension for each additional tap; protractor, 1 deg divisions, with every 10 deg labeled.

CIRCLE 328 ON READER SERVICE CARD



Absorbers
LOW FREQUENCY

MCMILLAN INDUSTRIAL CORP., Brownville Ave., Ipswich, Mass. Types BB and BP absorbers provide effective attenuation for free space room testing of antennas from 35,000 Mc down to 50 Mc in the case

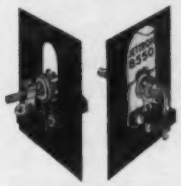
Special Sockets and Connectors

by jettron®

...FROM DESIGN TO PRODUCTION

Jettron is fully-equipped to design and manufacture your precision electronic components including connectors, sockets and cable assemblies. Call or write Jettron for quotations on "specials" for all commercial and military applications.

CD-7140 — Printboard Application Socket for R.C.A. Micromodule. Measures only .400 maximum square by .094 high. Insulation resistance greater than 50,000 megohms. Employs silver plated beryllium copper contacts and DIALL FS-5 insulating material.



CAT. 8550—Ultra High Frequency Socket for the G.E. GL-6299 Triode is sold in kit form containing all the necessary parts for mounting by the customer on a chassis barrier. It provides excellent isolation of the input from the output.

CAT. 8715—Ultra-High Temperature Socket for G.E. 7296 Triode can be soldered to printboard or mounted above or below a chassis. High Alumina insulating material; contacts gold plated Inconel-X. For continuous operation at 1000° F (538° C).

JETTRON PRODUCTS • INC

56 Route 10, Hanover, New Jersey
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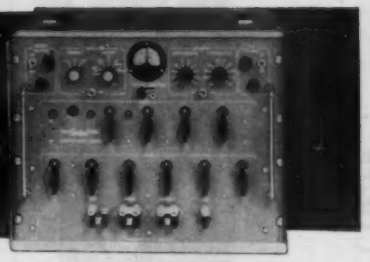
Sales Engineers in Principal Cities

CIRCLE 132 ON READER SERVICE CARD

Gertsch Complex Ratio Bridge



-measures both in-phase and quadrature voltage ratios - with high accuracy

This instrument cancels quadrature effects, giving a sharp, true null.

In eliminating quadrature voltage, this Gertsch bridge achieves an in-phase ratio accuracy as good as 0.001%. Quadrature voltage ratios are read as rectangular coordinates, tangent of phase-shift angle, or magnitude of phase-shift angle in degrees directly.

Write for complete data in Bulletin CRB.

- SELF-CONTAINED PHASE-SENSITIVE DETECTOR
- SIX-PLACE RESOLUTION
- TWO FREQUENCY RANGES
  - –30 TO 1000 CPS
  - –50 TO 3000 CPS

Gertsch

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Write for applications assistance and data.

FULL-WAVE TRIGGER (HALF ACTUAL SIZE)

POWER CONTROLS
Division of
Ovitron
CORPORATION
37-05 48th Ave., Long Island City 1, N. Y.

of the BB-96. Advantages are: (1) elimination of supporting structure —a distinctive cost reduction; (2) a new design principle permitting significant cost-cutting per unit volume of absorber; (3) fire-resistant, rugged construction; (4) reduction of shipping space—in shipment they occupy a fraction of their installed volume. Types BB and BP are priced at $5 per sq ft and up. Complete free space rooms, custom-made, can be delivered in four weeks.

CIRCLE 329 ON READER SERVICE CARD

Power Amplifier
MINIATURIZED

TELE-DYNAMIC DIVISION, American Bosch Arma Corp., 5000 Parkside Ave., Philadelphia, Pa., has introduced a miniaturized power amplifier designed to provide the final boost that insures reception of usable signals in long-range telemetry transmissions. Suited for space probes and satellites, ballistic missiles or drone aircraft, the unit is 4½ in. long, 2⅜ in. wide, and 2¼ in. high. It weighs 14 oz. Ruggedly built and completely shielded, the amplifier will put 15 w into the antenna over the entire 215 to 260 Mc telemetry band. Environmental characteristics include reliable operation at extreme temperatures and at altitudes up to 100,000 ft.

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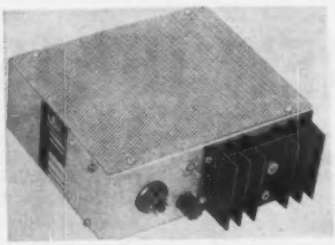

D-C Power Supply
SEMICONDUCTOR DESIGN

ELASCO INC., Five Prescott St., Roxbury 19, Mass., has developed a series of power supplies which of-

MAGNETIC POWDERED IRON

CLUTCHES

- ALSO MAGNETIC BRAKES AND CLUTCH BRAKES.
- For servo, computer, instrument, and other systems.
- Extremely fast response (as low as 0.25 ms).
- High torque to inertia ratio; no torque loss.
- Sizes 9, 11, 15, 18; standard and custom designs.
- Exclusive magnetic particle techniques; ultra-precision manufacture.
- Designed to MIL specs; rigid quality control.

Write for applications assistance and data.

SIZE 11 CLUTCH (ACTUAL SIZE)

HODGE CONTROLS
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fers outputs of 6, 12, 18, 24 and 28 v at 2 amperes each variable to ±1 v. Ripple is 5 mv peak to peak with line regulation of 5 mv and load regulation of 30 mv maximum. Response time is 50 μsec or less, no load to full load. The SV-2A Minisource series of full semiconductor design operate with an input of 105 to 125 v and a frequency range of 60 to 400 cps. Operating temperature is 0 to +50 C. Physical dimensions of the modular unit are 8½ in. by 8¾ in. by 3 in. high. Two units may be mounted side by side on a 3½ in. by 19 in. rack panel, or may be mounted as a subassembly on either the 8½ in. by 8¾ in. or 8½ in. by 3 in. face.

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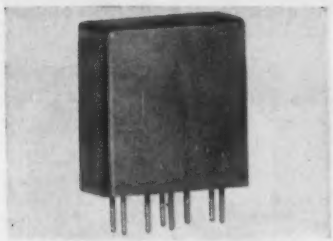

Voltage References
HIGH TEMPERATURE

VIKING INDUSTRIES, INC., 21343 Roscoe Blvd., Canoga Park, Calif. The 260 series voltage reference standards are designed primarily for high temperature military applications. Featuring a temperature coefficient of ±0.001 percent/deg C from −55 C through +150 C, these units operate directly from an unregulated 26.5 v d-c source. Regulation is ±0.005 percent for ±10 percent line voltage change. Approximately 1 ma current is delivered to an external load. Outputs are available at either 5.8 or 8.5 v d-c. Units are packaged in miniature crystal cases (¾ in. by ⅝ in. by ⅜ in.) and are designed for insertion into miniature relay sockets. All semiconductor components are silicon; resistors are wire wound all-welded construction.

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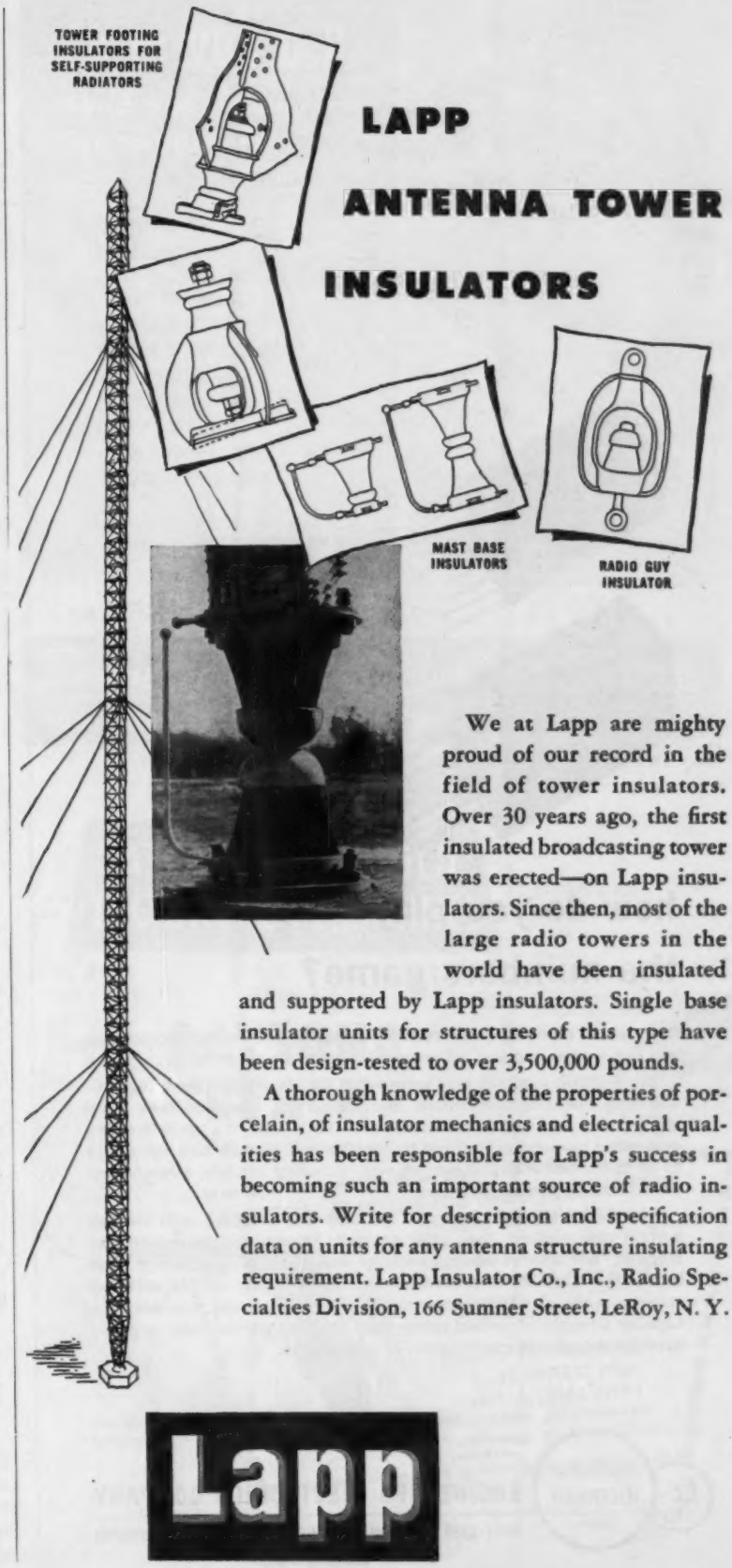
Testing Unit
SAVES SPACE, TIME

ALPHA ELECTRIC REFRIGERATION, 1115 East Seven Mile Road, Detroit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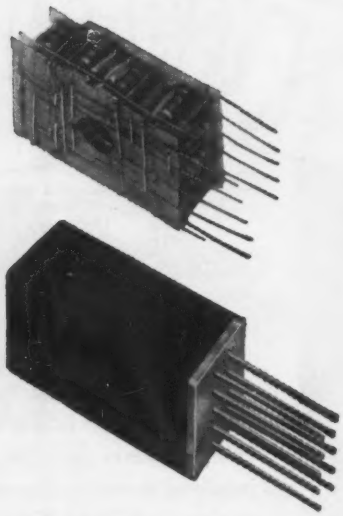
We at Lapp are mighty proud of our record in the field of tower insulators. Over 30 years ago, the first insulated broadcasting tower was erected—on Lapp insulators. Since then, most of the large radio towers in the world have been insulated and supported by Lapp insulators. Single base insulator units for structures of this type have been design-tested to over 3,500,000 pounds.
A thorough knowledge of the properties of porcelain, of insulator mechanics and electrical qualities has been responsible for Lapp's success in becoming such an important source of radio insulators. Write for description and specification data on units for any antenna structure insulating requirement. Lapp Insulator Co., Inc., Radio Specialties Division, 166 Sumner Street, LeRoy, N. Y.
Lapp



how do you play the numbers game?

The current numbers game consists of seeing how many components you can wedge into a small space. But there's a catch to it.

Some circuit modules may seem small until you string them together and find that interconnections and supporting structure take more space than the modules themselves. That's why it's important, in evaluating miniaturization, not to consider the module size alone, but to be concerned with the over-all size, including module, interconnections, and supporting structure.

New EECO MINIWELD circuit modules are designed with over-all system size in mind. They offer optimum miniaturization not only of modules, but also of interconnections and supporting structure. Add to this the reliability of proven circuits incorporating readily available standard catalog components rather than hard-to-get specials, the superior strength of welded rather than soldered connections, and you have an unbeatable combination of advantages.

Write, wire, or 'phone today for detailed information on the revolutionary new MINIWELD space-saving package.

ENGINEERED ELECTRONICS Company

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Kimberly 7-5651

3, Mich. The Space Saver is a compact quality control and reliability testing unit. It is composed of a rollabout type chassis cart and three separate, self-contained cabinets: high-low temperature, humidity, and high heat temperature. Cabinets are available with either mechanical refrigeration or liquid CO_2. Removable for use on or off of the cart, the cabinets allow three individual testing procedures to be conducted at the same time. This eliminates time usually lost waiting for test facilities. Cabinets are 24 by 22 by 22 in. with 12 by 12 by 12 in. work areas. Testing above and beyond MIL E 5272C specs, the Space Saver is considered ideal for testing of electronic components, instruments and many industrial and research projects.

CIRCLE 333 ON READER SERVICE CARD

Acceleration Sensor
DIRECT INDICATING

EASTERN TECHNICAL ASSOCIATES, INC., Main St., North Acton, Mass. The AI-1 acceleration indicator is a light weight direct indicating acceleration sensor. It is intended for use wherever a record of maximum shock or acceleration received is desired. Some uses are aircraft landing gear, shock testing of equipment and shipping of delicate instruments or other equipment. Range is 0-150 g; accuracy, ±5 percent of full scale; natural frequency, 30 cps (calc.).

CIRCLE 334 ON READER SERVICE CARD

Plastic Laminate
FOR P-C USES

FORMICA CORP., a subsidiary of American Cyanamid Co., Cincinnati, O., has developed a reinforced copper clad plastic laminate, designated XXXP-36RE. The new paper-

base grade has superior impact resistance and flexural strength. The properties make it ideal for printed circuitry applications in which laminated plastic circuits bear weighty components and are subjected to constant hard use. The reinforced grade is supplied in $\frac{3}{32}$ in. to $\frac{1}{4}$ in. thicknesses, with semi-gloss finish. Typical properties of $\frac{1}{16}$ in. XXXP-36RE: izod impact—lengthwise, 2.50 ft lb/in. notch; crosswise, 1.10 ft lb/in. notch; flexural strength—lengthwise, 24,000 psi; crosswise, 17,000 psi.

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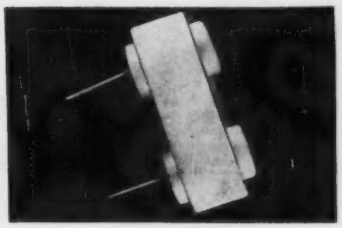

Crystal Sockets
SUBMINIATURE

GARLOCK ELECTRONIC PRODUCTS, Garlock Inc., Camden 1, N. J., has introduced subminiature, low loss crystal sockets designed to conserve space in wired or printed circuit applications. One of the chief advantages of the units is the Teflon body which virtually eliminates the dangers of breakage during assembly operations as encountered with ceramics. The sockets are designed for use wherever low loss, frequency stability and mechanical shock and vibration are problems. The contacts are made of silver plated beryllium copper.

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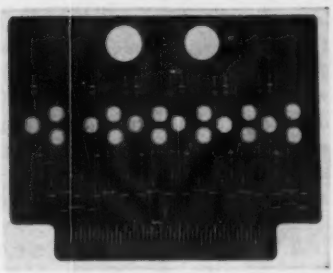

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Send your prints for quotations

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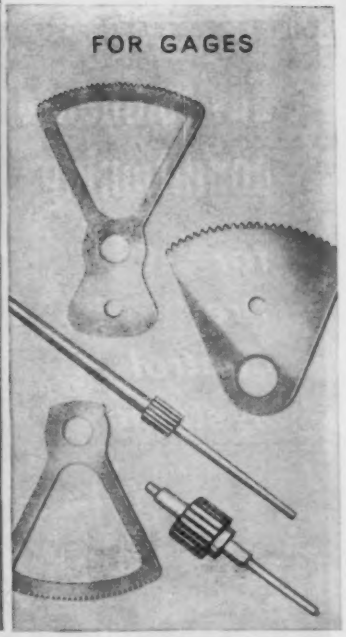

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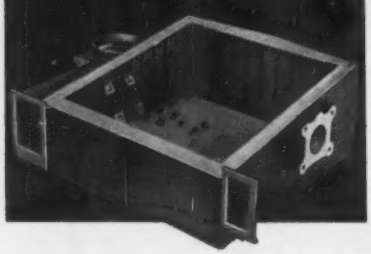
Environmental conditioning

for fire control systems



AiResearch integrated environmental conditioning of aircraft fire control systems achieves high effectiveness while reducing space and weight requirements.

Representative of AiResearch progress is this air-to-air environmental conditioning package which uses the integral heat exchanger and cold plate cooling unit as the base and mounting frame of the pressurized enclosure for the fire control system transmitter. Net weight of this unit is 9.5 lb. with a heat rejection of 425 watts.

This example illustrates the important economies which can be achieved when AiResearch is contacted early in the design stage of electronic systems.

Environmental conditioning equipment has been produced for the following electronic systems:

Detection · Communication · Control · Ground Support · Guidance

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is an inexpensive accurate digital-to-analog converter available as standard plug-in etched modules. Each module contains 6 stages and can be used as a 6-bit converter. Two identical modules can be interconnected to form a 12-bit converter, with 0.1 percent accuracy. Settling time for a full scale voltage change, 10 v, is 2 μsec. The converter can be driven by Abacus Stroke gates and flip-flops. Output impedance of the converter is 2,250 ohms. Price is $275 per module ($550 per 12-bit converter). Delivery is three weeks.

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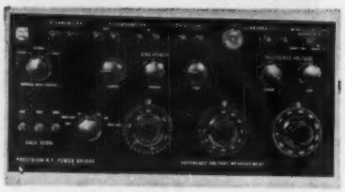

R-F Power Bridge
PRECISION UNIT

WEINSCHEL ENGINEERING, 10503 Metropolitan Ave., Kensington, Md., announces model PB-1 precision r-f power bridge with which ¼ percent accuracy of substituted d-c power (above 500 μw) can be achieved. The new unit is designed for use with 200 ohm bolometer mounts using either 4.5 or 8.75 ma barretters or a pair of 13 ma thermistors.

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Single Crystals
OF GALLIUM ARSENIDE

CRYS-TECH INC., 1534 East Chestnut St., Santa Ana, Calif., has available single crystals of gallium arsenide. Current stock includes both N- and P-type material in crystal sizes ranging from 30 to 75 grams. Undoped material typically has a carrier mobility of 3,000 cm^2/volt second and 10^{18} net carriers/cm^3. Zinc doped P-type material is available in a variety of resistivities from 0.06-0.07 down to 0.003-0.005 ohm cm. Crystals are grown by a pulling process on a (111) growth axis. Present plant capacity is 250 grams per week with additional expansion in progress.

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SEC tubular capacitors are manufactured under unusually critical quality control standards, resulting in tolerances as low as 0.5% in most values, and hermetic sealing guarantees accuracy over wide environmental changes.

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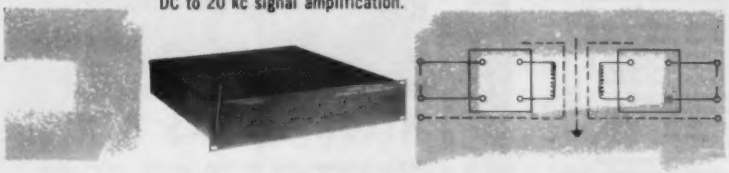

Used alone, the DIFFERENTIAL ISOLATOR functions as a DC to 20 kc isolation transformer. Input circuitry isolated from output circuitry (horizontal); chassis and all circuitry isolated from ground (vertical). ■ Isolates different common mode levels. CMR: 130 db to 1 kc. High output: ±5 v at ±30 ma or ±10 v at ±20 ma. Unity gain. Frequency response: less than 3 db down at 20 kc.

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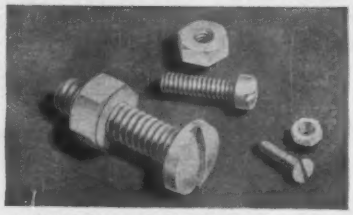

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Maximum size 1¼" long—.03 oz.

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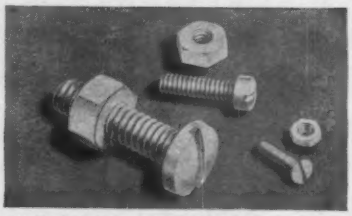

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new two-color bulletin. The type PW units described are available in ratings of 3, 5, 7, 10, 15 and 20 w, each featuring fireproof inorganic construction.

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AUTOMATIC CHECKOUT General Electric Co., 600 Main St., Johnson City, N. Y. Brochure 2549M2 describes a new approach taken by the company in automatically testing the operational readiness of electronic equipment at flight line, launch pad, aboard aircraft carriers, and at depot, shop maintenance and factory quality control levels.

CIRCLE 347 ON READER SERVICE CARD

CRYSTAL FILTERS Systems, Inc., 2400 Diversified Way, Orlando, Fla., has available a new catalog describing a line of precision crystal filters.

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MAGNETIC COMPONENTS Wilcox Electric Co., 1400 Chestnut St., Kansas City 27, Mo., has published a four-page, four-color folder describing its general facilities, capabilities, and magnetic components line.

CIRCLE 349 ON READER SERVICE CARD

DIGITAL COMPUTER Packard Bell Computer, 1905 Armacost Ave., Los Angeles 25, Calif. The pb250, a recently announced general purpose digital computer, is fully described in a new 3-color, 6-page brochure.

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EXPERIMENTER'S CHASSIS KIT Vector Electronic Co., 1100 Flower St., Glendale 1, Calif. A recent catalog sheet illustrates and describes two experimenter's chassis kits which provide quick set up of electronic circuitry with simple hand tools.

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METALLIC FILM RESISTORS Corning Electronic Components, Bradford, Pa. Low cost metallic film resistors (C-20 and C-32 for ½-w and 1-w sizes respectively) are described in a recent specification sheet. Requests for the sheet should be made under company letterhead.

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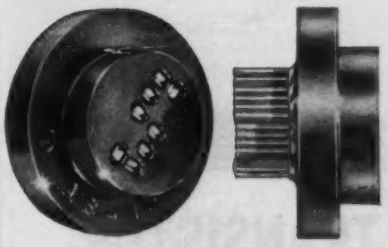

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NEW BOOKS

Encyclopedia on Cathode-Ray Oscilloscopes and Their Uses

By JOHN F. RIDER and SEYMOUR D. USLAN

John F. Rider, Publisher, Inc., New York, 1960, 1,306 *p*, $21.95.

THIS second edition is a giant book in every respect. Not only is it a well-written, well-illustrated encyclopedia of oscilloscope design, practical applications and auxiliary equipment, but quite a treatise on many electronic subjects ranging from simple cathode-ray tubes to designing broadband amplifiers.

The book itself is divided into five sections. Section 1 covers the basic characteristics of cathode-ray tubes, focusing, deflection and characteristics of phosphors. Section 2 discusses oscilloscope circuits and operation in detail. The basic oscilloscope, vertical and horizontal amplifiers, time bases, synchronization, power supplies and auxiliary equipment including such devices as electronic switches, various types of waveform generators, preamplifiers and other varied types of auxiliary equipment that can be used with a modern oscilloscope are covered in this section. Special purpose cathode-ray tubes including camera and storage-type tubes are also discussed.

Section 3 is concerned with oscilloscope applications. Detailed discussions of such subjects as basic pulse measurement, phase and frequency measurement, audio frequency testing, transmitter testing, how to use the oscilloscope in visual alignment of tv, f-m and a-m radios, and medical and scientific applications of the oscilloscope make this a very interesting section. Oscilloscope photography is also covered thoroughly.

Section 4 covers waveform analysis including complex waveforms and square-wave testing of RC coupled amplifiers and networks. This section is profusely illustrated with sample curves and resultant waveforms to illustrate how various forms of distortion appear on the oscilloscope.

Section 5 consists of schematics

and pertinent information on some 78 different oscilloscopes ranging from kit versions to expensive laboratory-type instruments. L. S.

Information Transmission, Modulation and Noise

By MISCHA SCHWARTZ
McGraw-Hill Book Co., Inc., New York, 461 *p*, $11.

MATERIAL presented in this text is intended to form the basis for a senior level systems course in electrical engineering. As such, it serves a useful purpose in filling a gap that prevails in many electrical engineering curricula. The gap, brought about by a lack of good approach correlating theory with application, manifests itself by the inability of the undergraduate to apply communication theory to system design.

Unlike many recently published texts attempting to integrate application with theory, the author is aware of the application to system design throughout the entire text. The sequence of subjects is well coordinated with the design criteria that the author draws upon to illustrate the various compromises and decisions that have to be made in communication system design. As an example of the completeness of the text in this respect, one entire chapter (Chapter 6—Comparative Analysis of Systems) is devoted to exploiting various advantages and disadvantages of the variety of modulation systems previously treated.

The instructive material covers topics in communications theory ranging from transmission through electric networks to the role of statistical methods in analyzing communications systems. Included in this coverage are Laplace transforms, Fourier transforms, transmission through ideal filters, amplitude modulation, frequency modulation, the sampling theorem and pulse modulation, noise and many others. The material is well integrated and presented in a manner that is very easily understood.

In summary, the text is an excellent one in the field of information transmission with the additional bonus of providing an equally excellent treatment of communication system design.—RALPH J. MAS-

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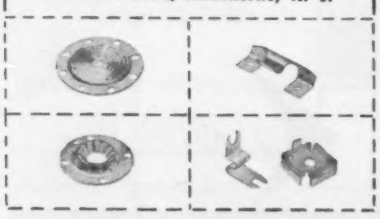

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THUMBNAIL REVIEWS

The A.R.R.L. Antenna Book (ninth edition). Published by American Radio Relay League, West Hartford, Connecticut, 1960, 320 p, $2. A new edition of an always-useful work, the volume covers basic theory of antennas and transmission lines in easy-to-read language and then presents a number of tested antenna designs for those amateurs who do not wish to do their own calculations. Lots of practical construction details and operating hints.

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Advances in Space Science—Vol. 1. Edited by Frederick I. Ordway III, Academic Press Inc., New York, 1960, 412 p, $12.00. This is the first in a series of volumes designed to permit workers in the various fields of astronautics to keep abreast of developments in their own and related specialties. The first three chapters deal with interplanetary rocket trajectories, interplanetary communications and power supplies. Remaining three chapters consider in turn manned space cabin systems, radiation effects on man in space and nutrition in space flight.

Basic Carrier Telephony. By David Talley, John F. Rider Publisher, Inc, New York, 1960, 176 p, $4.25 soft cover, $5.75 cloth binding. Excellent student level text book on basic carrier telephony. Covers all phases of signaling over wire, cable and radio circuits. The text starts with fundamental principles and goes through basic circuit elements to applications of equipment to telephone communication systems. Good refresher book for radio engi-

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neers engaged in communication systems.

Physique des Circuits. By P. Grivet and R. Legros, Masson & Cie, Paris, 1960, 553 p, 90 NF. First of five-volume course in electronics, this volume covers at length circuit elements and basic network theory. Makes liberal use of mathematics but remains to the point. Well illustrated, each chapter has extensive international bibliography. Does not require extensive knowledge of French, would make a good reader for the electronic engineer who is learning to read scientific French.

Electronic Switches, Timing, and Pulse Circuits. By J. M. Pettit, McGraw-Hill Book Co., Inc., New York, 1960, 267 p, $7.50. A practical tool for engineers who design switching circuits. Covers such topics as electronic switching elements, multivibrators and generation of linear voltage slopes. The author emphasizes the use of graphic techniques and provides numeric examples. Although written as a text for college seniors, the tube and transistor circuits detailed are useful to the practicing engineer. With the typical applications provided in the first chapter, the reader has some feeling for the usefulness of the circuits presented in later chapters.

Physique Et Technique Des Tubes Electroniques (Vol. II, Theorie et Fabrication des Tubes). By R. Champeix, Dunod, Paris, 214 p, (price not available). Having treated the subject of vacuum physics in an earlier work, M. Champeix in this book dealing with tubes affords an excellent opportunity for the French reader to acquaint himself with some of the more recent developments in vacuum tube technology. Initially, it deals with basic electron physics by way of summarizing tube theory, and takes the reader through electron flow in metals, emission, and provides a more than adequate examination of what goes on inside several types of tubes. Further chapters deal with materials and elements and discusses their applications to manufacturing processes. In doing this, the author provides a commendable balance between theory and actual technique. Although there would be little in the way of startling new information that an English translation of this book would provide to a serious student of tube technology in the United States, this book fills a gap long empty in the professional life of the French vacuum tube specialist.

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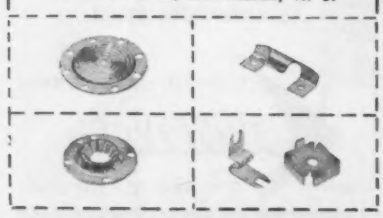

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Basic Carrier Telephony. By David Talley, John F. Rider Publisher, Inc, New York, 1960, 176 p, $4.25 soft cover, $5.75 cloth binding. Excellent student level text book on basic carrier telephony. Covers all phases of signaling over wire, cable and radio circuits. The text starts with fundamental principles and goes through basic circuit elements to applications of equipment to telephone communication systems. Good refresher book for radio engi-

neers engaged in communication systems.

Physique des Circuits. By P. Grivet and R. Legros, Masson & Cie, Paris, 1960, 553 p, 90 NF. First of five-volume course in electronics, this volume covers at length circuit elements and basic network theory. Makes liberal use of mathematics but remains to the point. Well illustrated, each chapter has extensive international bibliography. Does not require extensive knowledge of French, would make a good reader for the electronic engineer who is learning to read scientific French.

Electronic Switches, Timing, and Pulse Circuits. By J. M. Pettit, McGraw-Hill Book Co., Inc., New York, 1960, 267 p, $7.50. A practical tool for engineers who design switching circuits. Covers such topics as electronic switching elements, multivibrators and generation of linear voltage slopes. The author emphasizes the use of graphic techniques and provides numeric examples. Although written as a text for college seniors, the tube and transistor circuits detailed are useful to the practicing engineer. With the typical applications provided in the first chapter, the reader has some feeling for the usefulness of the circuits presented in later chapters.

Physique Et Technique Des Tubes Electroniques (Vol. II, Theorie et Fabrication des Tubes). By R. Champeix, Dunod, Paris, 214 p, (price not available). Having treated the subject of vacuum physics in an earlier work, M. Champeix in this book dealing with tubes affords an excellent opportunity for the French reader to acquaint himself with some of the more recent developments in vacuum tube technology. Initially, it deals with basic electron physics by way of summarizing tube theory, and takes the reader through electron flow in metals, emission, and provides a more than adequate examination of what goes on inside several types of tubes. Further chapters deal with materials and elements and discusses their applications to manufacturing processes. In doing this, the author provides a commendable balance between theory and actual technique. Although there would be little in the way of startling new information that an English translation of this book would provide to a serious student of tube technology in the United States, this book fills a gap long empty in the professional life of the French vacuum tube specialist.

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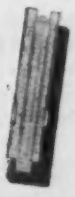

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CIRCLE 147 ON READER SERVICE CARD

Reflectone to Build In Florida

REFLECTONE ELECTRONICS, INC., recently broke ground for its new Florida facility on a 10-acre site in Plantation, near Fort Lauderdale. This expansion will provide an important manufacturing supplement to the company's plant in Stamford, Conn., presently being enlarged.

The new Florida facility will be devoted primarily to production of components for the company's diverse line of electronic systems. The plant will also house an additional portion of Reflectone's advanced research and development activities in the field of electronic simulation and control.

The construction schedule, with initial land and building costs estimated at $200,000, calls for completion of the plant within about six months.

When operations at the 10-acre site are fully under way, employment could reach several hundred.

Founded in 1940, Reflectone has developed into a multimillion dollar firm engaged in the design and manufacture of electromechanical simulation and training systems, missile and armament training devices and other specialized electronic systems. The company has been a prime contractor in several major defense areas. Currently, Reflectone is developing complex training installations for B-58 supersonic bomber crews, and has just completed the navigational trainer for the crew of the Polaris missile-firing submarine *George Washington*.

A highly-specialized and unusual area of the electronics industry, electronic simulation becomes more vital and challenging as control systems become more complex. The artificial creation of actual operating conditions is necessary for training of missile, aircraft, submarine, weapon system, and other military crews and personnel.

In addition to training systems, Reflectone produces, as a part of its diversification program, a number of products used widely in industry, such as p-m motors for dictating machines, integrators, power supplies, transistor testers and optical equipment.

AIL Promotes Miles To Division Director

RAYMOND C. MILES has been named director of the engineering and production division of Airborne Instruments Laboratory, a division of Cutler-Hammer, Inc., Deer Park, N. Y.

He has been with AIL since 1950 where he was in charge of the electrical design section of the engineering department, head of the industrial products department, and manager of the government products department.

Stewart-Warner Elects Vice President

FRANK A. RYDER, general manager of the John W. Hobbs Corp., Springfield, Ill., a division of Stewart-Warner Corp., has been elected a vice president of Stewart-Warner.

With S-W since 1944, Ryder became general manager of the Hobbs Division in June 1959.

Swain Takes New Post At CBS Electronics

ROBERT G. SWAIN has been named to the new post of product planning manager, semiconductors, for CBS Electronics, Danvers, Mass.

He had been eastern regional sales manager for semiconductors and before that was supervisor of field engineering, eastern region.

Vitro Laboratories Names Joehlin

NORMAN C. JOEHLIN has been appointed head of the digital systems group at Vitro Laboratories, West Orange, N. J. He was formerly senior engineer of Magnavox Co. in Urbana, Ill., and Ft. Wayne, Ind.

Datex Organizes Servomechanism Group

FORMATION of a new servomechanism group within Datex Corp.,

The Avnet System

creates a new Concept of Scheduling

30 days hath September, April, June and November. All the rest have 31 except The Avnet System, whose calendar is the delight of engineers and electronic purchasing men all over America. Yes, there are 30 days in Avnet's November, but your order knows no weak-ends. Within the same 30 days, The Avnet System ships more orders than any other major source of supply. Your specific order therefore, can be scheduled for quicker delivery, faster use.

This new Concept of Scheduling according to customer convenience rather than calendar convenience is one of the many advantages in The Avnet System. *Avnet maintains a network of Sales Engineers traveling the U.S. Each engineer has his counterpart in a Service Center Expediter. Tremendous stocking facilities are maintained strategically throughout the country. Avnet maintains and operates complete assembly facilities for Connector Prototype requirements.* For the most expeditious Scheduling contact your nearest Service Center in The Avnet System.

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Avnet Service Centers and Stocking Facilities are located in Los Angeles, Cal.; Sunnyvale, Cal.; Chicago, Ill.; Dayton, Ohio; Westbury, L. I.; Burlington, Mass.

Avnet distributes from its stocking facilities: BENDIX SCINTILLA CONNECTORS, SPERRY SEMICONDUCTORS, RHEEM SEMICONDUCTORS, ELECTROSNAP AND HETHERINGTON SWITCHES, GREMAR CONNECTORS, CLARE RELAYS, ROBERTSON SPLICE & CONNECTOR CASES, BABCOCK RELAYS, KING SUBMINIATURE HI-TEMP CERAMIC CAPACITORS, TIC PRECISION TRIMMERS, VIBREX FASTENERS by GENERAL TIRE & RUBBER CO., U. S. SEMCOR SEMICONDUCTORS, SANGAMO CAPACITORS, SPRAGUE CAPACITORS

Analog to Digital
CONVERTERS

for Linear or
Angular Motions

IDL Shaft Angle Converters

are fully qualified
per MIL-E-5272 A

for Operation:

At temperatures 0°F to 160°F
per Paragraph 4.1.1 Procedure 1
From 0.55 to 14.7 p.s.i.a.
per Paragraph 4.5.3 Procedure 3
Under vibration 5-5000 cps
per Paragraph 4.7.1 Procedure 1

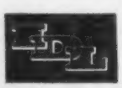
for Exposure:

To Humidity and Temperature
per Paragraph 4.4.4 Procedure 1
To Sand and Dust
per Paragraph 4.11.1 Procedure 1
To 50 hour Salt Spray
per Paragraph 4.6 through 4.6.13
To Shock
per Paragraph 4.15.1 Procedure 1 and Paragraph 4.15.2.1
To 10 G's Sustained Acceleration
per Paragraph 4.16.2 Procedure 2

For Linear Motions, Model 500206 provides accuracies of 1 part in 1000 counts.

For Angular Motions, Model 500406 provides accuracies of one tenth degree; Model 500407 provides accuracies of a tenth of a minute.

Each unit provides bidirectional rotation for applications in mechanically geared systems. The Gray BCD coding system is easily translated into other digital format for visual readout or for recording.



For specifications on these components, ask IDL for their data sheet, "Shaft Position to Digital Converters" or price information, use your letterhead.

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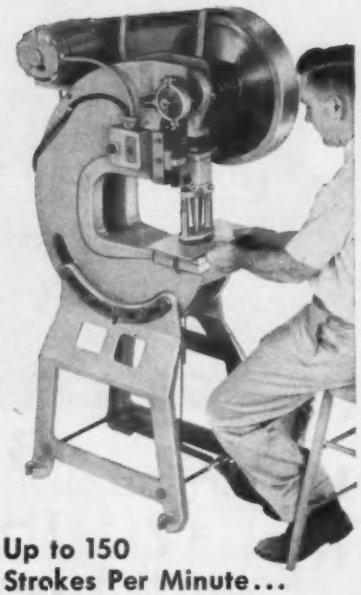

Up to 150 Strokes Per Minute...

NEW DI-ACRO OPEN BACK INCLINABLE PUNCH PRESS NO. 5

This new bench type punch press has five tons of power for punching, forming, shearing, marking, riveting, staking or embossing. Single stroke cycling, 150 s.p.m., or continuous operation, 210 s.p.m. Deep 12 inch throat allows working to center of 24" sheet. Spring loaded material stripper—easy to set up—ideal for women operators or inexperienced help. Standard equipment includes motor, brake, flywheel guard, all electrical connections, punch holder, stripper assembly and die holder.

HAND OPERATED PUNCH PRESSES—Di-Acro Punch Presses No. 1 and 2 both provide 4 tons of power that will punch holes up to 4" round in 16 ga. mild steel using punches with shear. No. 1 has 6¼" throat depth and No. 2 a 12¼" throat depth. Both models come with short handle, long handle for heavier materials, punch and die holders, turret stripper, back and side gauges.

PRECISION PUNCHES AND DIES—Over 500 sizes of single station Di-Acro punches and dies are available from factory stock, plus adjustable punches and dies for multiple punching in one operation.

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See complete Di-Acro line in Sweet's Machine Tool Catalog

di-acro PRECISION METALWORKING EQUIPMENT

O'NEIL-IRWIN MFG. COMPANY
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Lake City, Minnesota

Monrovia, Calif., has been announced. The new engineering unit will be responsible for the design of precision servo systems, servo repeaters and special purpose analog computing equipment for industrial control and military applications.

The new group will be headed by DeLano Brouillette, who will report to Richard Bazard, systems engineering manager.

Pyburn Joins DCS Management Team

ROY W. PYBURN was recently appointed assistant to the president of Data-Control Systems, Inc., Danbury, Conn. He comes to DCS from Ampex Corp., Redwood City, Calif., where he has been for the past four years senior product planning engineer, responsible for market research and evaluation of the future requirements of the telemetry and research-data industry.

Ling-Temco Forms New Division

LING-TEMCO ELECTRONICS, INC., Dallas, Texas, recently announced the formation of a new unit—micromodular components division—which will design, produce and market logic circuitry modules for transistorized computers, custom semiconductor assemblies and high-voltage and low-voltage rectifiers.

General Electric Promotes Boyles

PROMOTION of Morris E. Boyles to the position of manager—components engineering, General Electric television receiver department, Syracuse, N. Y., has been an-

nounced. Formerly manager—engineering administration for the television receiver department, he has been with GE for the past ten years.

Precision Circuits Hires H. R. Reiss

HERBERT R. REISS has been named manager of the New Rochelle, N. Y., plant of Precision Circuits, Inc., designer and manufacturer of military and commercial printed wiring boards and assemblies. Prior to joining the company, he was with Sperry Rand Corp. in engineering posts associated with design and production of printed circuit boards and assemblies.

Clarostat Appoints Production Manager

OFFICIALS of the Clarostat Mfg. Co., Inc. announce the appointment of Douglas Haynes to the position of production manager. He will be responsible for the administration of all manufacturing departments, including industrial engineering, purchasing, production and material control, plant maintenance, tool design and manufacture, shipping and traffic departments.

Haynes has been associated with the company since 1958 as production control manager.

McGraw-Edison Ups George Anderson

GEORGE M. ANDERSON has been appointed president of the Thomas A. Edison Research Laboratories of the McGraw-Edison Co., West Orange, N. J. The laboratories serve as central research headquarters for the company's 43 divisions and subsidiaries in 16 states, Can-

VARIAN
Temperature
RECORDERS

Most versatile and useful because . . .

6. THEY'RE PORTABLE AND

MULTI-RANGE

Nine plug-in elements adapt this G-11A thermocouple recorder to any range—cold as liquid nitrogen, hot as 2200°F, or as specific as 30° to 220°F. Being portable, it goes wherever there's temperature to measure—research in the lab, checkout in the factory, or troubleshooting in the field.

The temperature recorder is a Varian G-11A with T-2 input chassis which has automatic reference junction compensation and plug-in range elements as shown. Other input chassis convert the recorder to general use. Fahrenheit or Centigrade charts available. For full details, write Instrument Division.

VARIAN associates

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tantalum foil electrolytic capacitors

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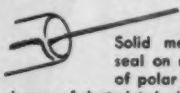
HIGH RELIABILITY



Solid metal hermetic seal on negative end of polar units reduces chances of electrolyte leakage by 50%.

Only one external butt weld on polar units minimizes possibility of lead wire breakage. (No weld on the negative end.) Leads on capacitors of 3/16" O.D. and larger withstand 3 lb. stress in any direction for 30 min. Welds withstand at least four "round trip" bends.

Internal Features. All electrical connections welded, for low resistance, low power factors. Capacitor section fits snugly into metal case, resulting in good vibration resistance. Plugged end of case is double-sealed with compressed bushing and tough resin.

iei also supplies a full line of aluminum foil miniature and sub-miniature electrolytic capacitors. Write for bulletins 41858 and 81558. International Electronic Industries, Inc., Box 9036-AA, Nashville, Tennessee.

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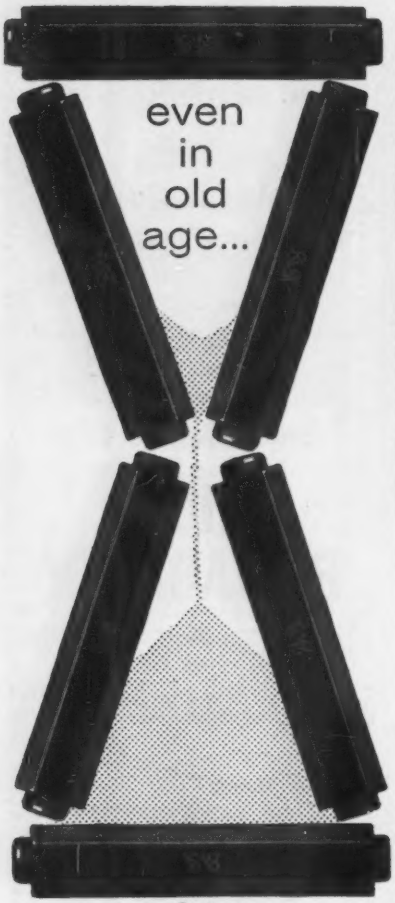

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RANGE FROM 1000 OHMS TO
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On your left are some of our stock terminal insulators. They are made in large runs for economical, off-the-shelf delivery.

Coors furnishes either metalized ceramic parts ready for brazing by the customer, or complete ceramic-to-metal assemblies in sizes up to 10" OD by 12" length.

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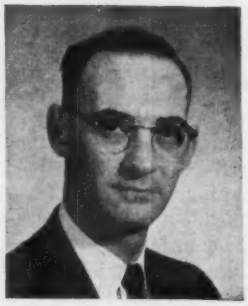
CIRCLE 223 ON READER SERVICE CARD

ada, England and Mexico.

Before being named president, Anderson was head of the Edison Research Laboratories' engineering department.

L&N Names Nichols Division Manager

CLARK NICHOLS has been made manager of the systems engineering division of Leeds & Northrup Co., Philadelphia. Prior to this appointment he was head of the L&N application engineering utilities section. He joined the manufacturer of electronic instruments and controls in 1935.



Raytheon Advances Robert C. Berman

PROMOTION of Robert C. Berman to the new position of manufacturing services manager for the industrial components division of Raytheon Co., Newton, Mass., has been announced. His principal duties will be the insuring of maximum utilization of the division's physical assets, and the coordination of industrial engineering, plant engineering and other manufacturing services throughout the division's several operations.

Berman had served as assistant production superintendent at the company's North Dighton, Mass., plant, and also as manufacturing systems and procedures manager for the surface radar and navigation operations.

Electronic Tube Corp. Appoints Vaccaro

RECENTLY announced is the appointment of Charles A. Vaccaro as senior project design engineer, instru-

ment division, of Electronic Tube Corp., Philadelphia, Pa. He was formerly chief engineer of Waterman Products Co.

Magnetico Hires G. M. Clarke

GERALD M. CLARKE has been appointed assistant to the product manager of the amplifier division of Magnetico, Inc., East Northport, N. Y. He was formerly a product engineer at the Sperry Gyroscope Co., Great Neck, N. Y.

In his new post, Clarke will concentrate on Magnetico's advanced design of solid state devices for precise system control, particularly in the transistorized servo amplifier area.

Reeves-Hoffman Selects O'Hanlan

MICHAEL O'HANLAN, JR., has been appointed manager of the networks division, Reeves-Hoffman Division, Dynamics Corp. of America, Carlisle, Pa. In this post he will be responsible for the design, engineering, production and quality control of crystal oscillators, filters, and temperature-controlled ovens.

O'Hanlon was formerly assistant plant engineer of AMP, Carlisle manufacturer of solderless terminals.

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(Continued on pages 154-156)

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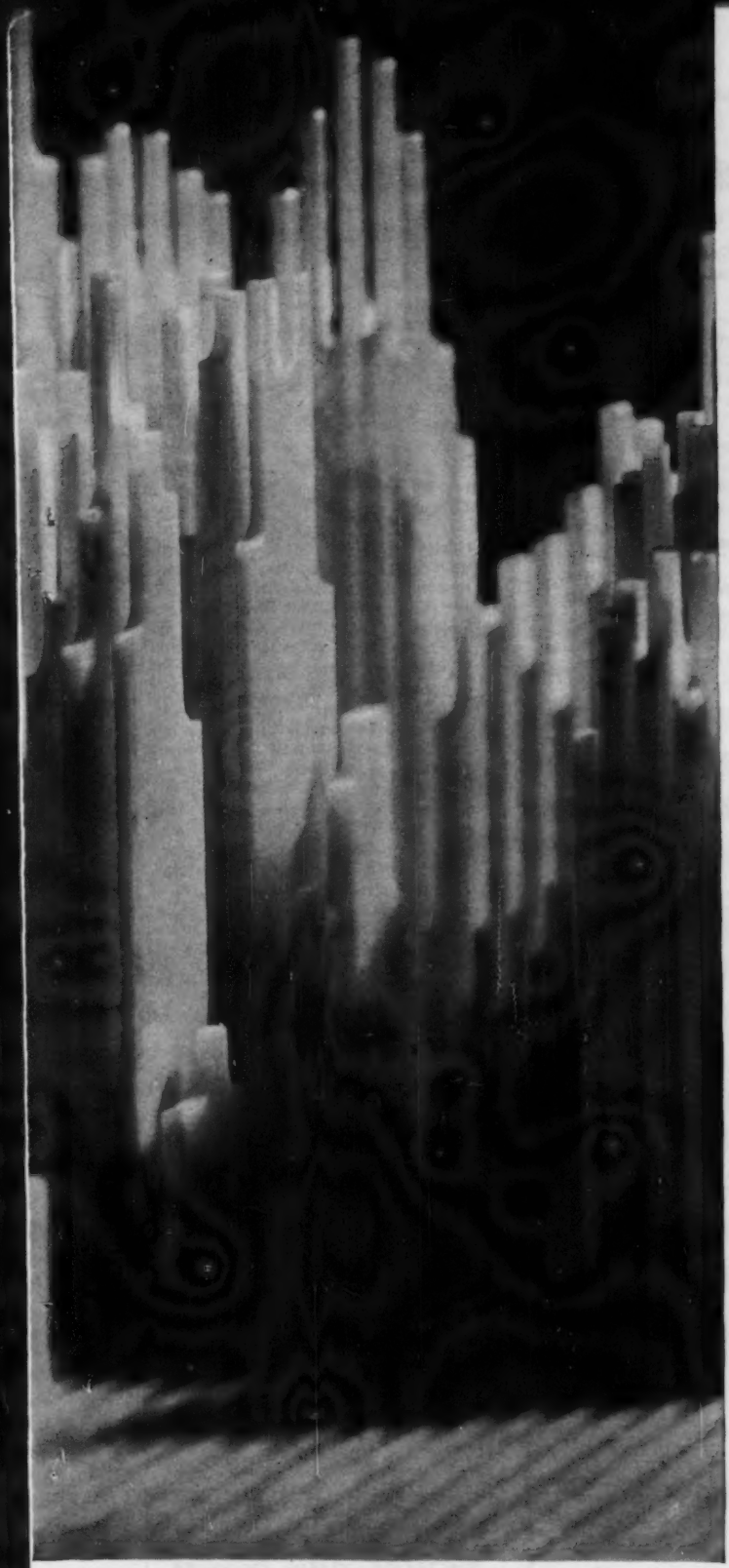

Representation of the frequency-energy pattern of the spoken word, "IBM." Horizontal axes: frequency and time. Vertical axis: energy. Sampling interval: 0.01 second.

Opportunities in
Systems Development

Looking at the sound of words

The plastic model shown here is a 3-dimensional representation of the frequency-energy pattern of the spoken word, "IBM." It is one of several similar models constructed from a computer analysis of speech information.

Now under study by IBM scientists and engineers, these representations are yielding clues to the most promising characteristics of spoken words for machine speech recognition. They are helping determine the characteristics that differ most consistently for different words. and are similar for repetitions of the same word.

Will Men Talk to Machines?

Interesting in themselves, the models are emblematic of a broad program of systems development aimed at making it possible for people to talk to machines.

Studies include investigation of new speech measurements and of circuits to perform these measurements; input and feedback devices; statistical analysis of the complex speech wave forms; and methods for efficiently storing the selected characteristics of known words for comparison with spoken words to be identified.

Just One of Many Opportunities

Speech recognition is one of many advanced technology projects now under way at IBM. Electronic engineers are exploring new areas in systems planning, display, and data communications. Mechanical engineers are developing unique devices for high-speed access to memory and document stores. Physicists and chemists are making contributions in photo materials and in electroluminescent and photoconductor devices.

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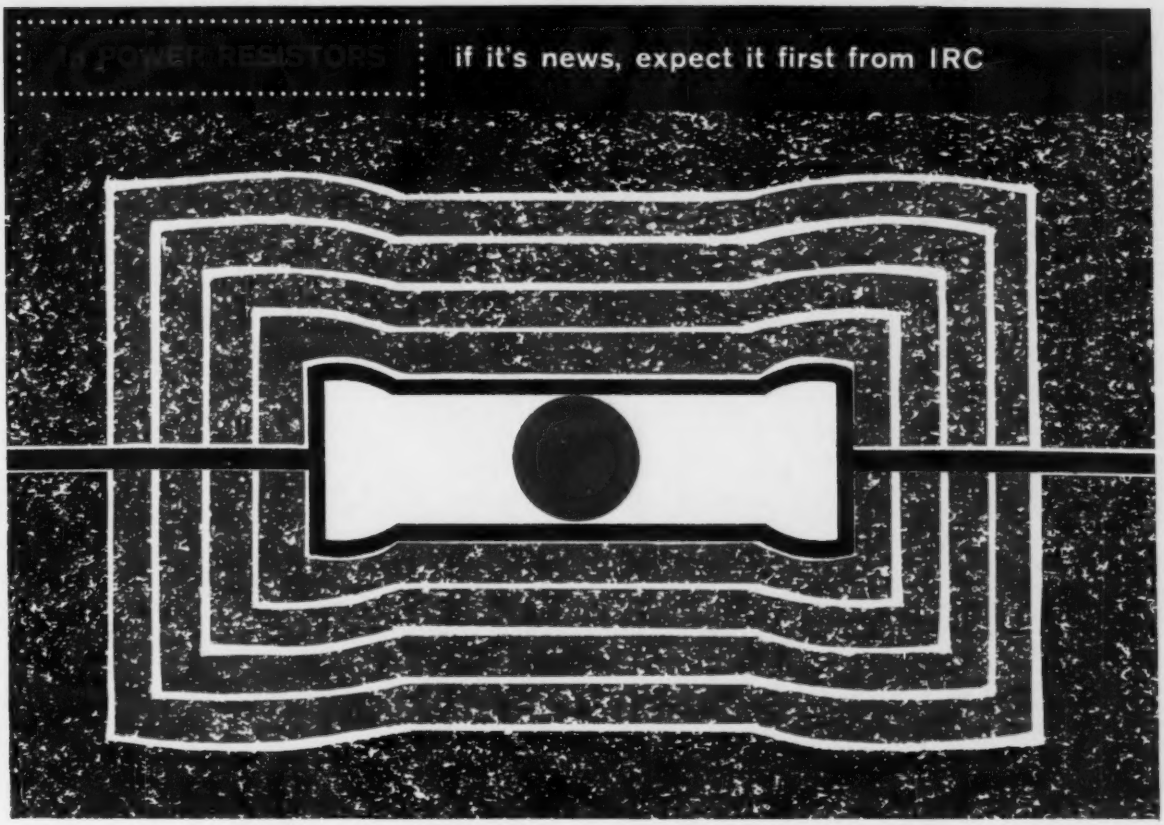

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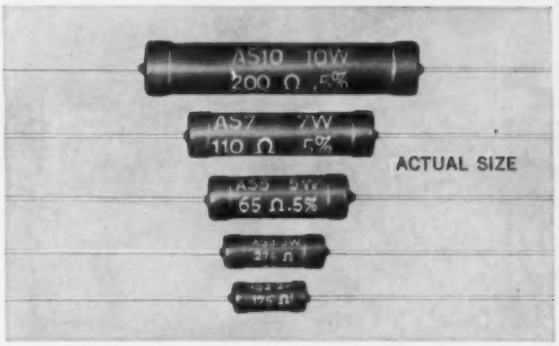

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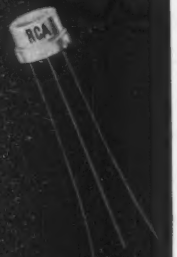

JEDEC TO-5 Case

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RCA 2N1511, 2N1512, 2N1513, 2N1514 in JEDEC TO-36 Case

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				V_{CB}=30v	I_C=1.5 amp	I_C=1.5 amp		
2N1514	100	55	6	25	0.67	25-75	60	30
2N1513	60	40	6	25	0.67	25-75	60	30
2N1512	100	55	6	25	2.00	10-50	60	30
2N1511	60	40	6	25	2.00	10-50	60	30
				V_{CB}=30v	I_C=1.5 amp	I_C=1.5 amp		
2N1490	100	55	6	25	0.67	25-75	60	30
2N1489	60	40	6	25	0.67	25-75	60	30
2N1488	100	55	6	25	2.00	10-50	60	30
2N1487	60	40	6	25	2.00	10-50	60	30
				V_{CB}=30v	I_C=0.75 amp	I_C=0.75 amp		
2N1486	100	55	3	15	1.00	35-100	15	7.5
2N1485	60	40	3	15	1.00	35-100	15	7.5
2N1484	100	55	3	15	2.67	15-75	15	7.5
2N1483	60	40	3	15	2.67	15-75	15	7.5
				V_{CB}=30v	I_C=0.2 amp	I_C=0.2 amp		
2N1482	100	55	1.5	10	7	35-100	4	2
2N1481	60	40	1.5	10	7	35-100	4	2
2N1480	100	55	1.5	10	7	15-75	4	2
2N1479	60	40	1.5	10	7	15-75	4	2

*sustaining volts

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